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Sulpiz Kurz,

Mr. S. Kurz, late Curator of the Herbarium at the Botanical Gardens, Calcutta, and one of our most valued contributors, succumbed to the effects of a tropical climate at Penang on the 15th January 1878. We feel sure the following sketch of his life, read by Dr. D. Brandis at the Meeting of the Asiatic Society of Bengal, will interest our readers:—

Sulpiz Kurz, Curator of the Herbarium at the Botanic Gardens, Calcutta, was born at Augsburg, in Bavaria, on the 5th May 1834. His father died early, and the boy attended school at Munich, where his mother had settled. At an early age he commenced collecting objects of natural history, especially insects. After leaving school he attended lectures at the University of Munich, and chiefly devoted himself to the study of Botany, Mineralogy and Chemistry. In 1854 misfortunes in his family compelled him to abandon his studies, and he went to Holland where he worked as an apothecary, and, after mastering the Dutch language, enlisted in the Subordinate Medical Service of the Dutch Colonial Army. He landed at Batavia in September 1856, and was sent to Banka in March 1857, where he remained two years. During that time his work was light, and he was able to explore the island and to make botanical collections. In 1859 he was re-called to Batavia and joined the Military Expedition to Bori in Celebes. In September 1859 Kurz returned to Batavia, and was appointed as an Assistant on the Staff of the Botanic Garden at Buytenzoorg. Here, for the first time in his life, he had the advantage of working under the guidance of other botanists, and with the assistance of a large library and a rich herbarium,

he devoted himself principally to Ferns, Bamboos, Musaceæ, Pandaneæ and other difficult groups. A few years later Dr. Thomas Anderson, the Superintendent of the Botanical Gardens, Calcutta, came to Java in order to study the system of Cinchona cultivation which had then for some time been established by the Dutch authorities. He induced Kurz, with the permission of the Dutch Government, to accept the appointment, which he held at the Herbarium of the Calcutta Botanical Gardens until his death. In October 1863 Kurz left Java, and joined his new appointment at the Gardens early in 1864.

Before his transfer to Calcutta he had not published much; a few papers only on the vegetation of Banka and other matters had been printed in the "*Naturkundige Tydschrift voor Nederlandsch Indie.*" In Calcutta, however, he commenced a series of important botanical publications, which appeared in English and Continental Periodicals, chiefly in the London Journal of Botany, the Proceedings of the Linnean Society, in Miquel's Annales, the Flora of Regensburg and the Botanische Zeitung. But his later and most important papers were published in the Journal of the Asiatic Society, of which he became a member in 1869.

In 1866, Kurz was deputed by the Government of India to Port Blair, in order to study the vegetation of the Andaman Islands. He spent the months of April and May on that duty, and the results of his explorations were recorded in a most valuable Report which was published by Government in 1870. While engaged in examining the interior of South Andaman, he was seized by the Burman convicts, whom the Superintendent of Port Blair had given to assist him in his work, and was left tied hand and foot in the jungles on the ground. These and subsequent circumstances, which prevented the more extensive excursions which he had projected through the islands, obliged Kurz to return to Calcutta sooner than he had intended.

In 1867, the Government of India decided to employ him on the preparation of a hand-book, intended chiefly for the use of forest officers, of the trees, shrubs and climbers grow-

ing in the forests of British Burma. To this new task, Kurz devoted himself with his usual ardour and enthusiasm, and his researches regarding the Flora of Burma may justly be regarded as the most important work of his life. From December 1867 to June 1868, Kurz explored the forests in the province of Pegu and part of those in Martaban. But when after his return to Calcutta he examined and arranged the rich materials collected by him, he found that many doubtful points remained, and he was accordingly deputed on a second tour to the same districts, which lasted from December 1870 until May 1871.

Besides the materials collected by himself, Kurz had the advantage of consulting large collections made by others in Burma, and he was thus enabled to describe numerous new genera and species. A number of Burmese plants collected by him are described by other Botanists, and deservedly bear his name. Between 1872 and 1877 he contributed two series of valuable papers to the Journal of the Asiatic Society. One series he called "New Burmese Plants," and the other, "Contributions towards the knowledge of the Burmese Flora." A general account of his researches was embodied in a quarto volume published by Government in 1875, under the title "Preliminary Report on the Forest and other Vegetation of Pegu." This work contains an admirable account of the vegetation in all parts of that province, as well as a most useful list of vernacular (Burmese) names of plants with their systematic names.

The chief results of his labours in regard to the Burma Flora, however, were embodied in his Forest Flora of British Burma—a work, regarding which it is not too much to say, that it has placed the name of Kurz in the first rank of Indian Botanists. This work was published towards the close of last year in two volumes, by order of the Government of India. It contains full and clear descriptions of 2,000 species, and will, for a long time to come, remain a standard work of reference for all interested in the vegetation of British Burma and the adjacent countries.

In 1875, Kurz took three months' leave, and devoted it to a botanical exploration of the Nicobars, but exposure and fatigue in the unhealthy climate of those islands brought on a severe attack of fever which much weakened his constitution. In 1876, he contributed to the *Journal of the Asiatic Society* a paper on the Vegetation of the Nicobars, based chiefly upon the collections made by the Austrian Naturalists, attached to the Novara Expedition. These collections had been sent to him for publication by the Director of the Imperial Museum at Vienna.

On the 12th November 1877, shortly after his Forest Flora had been published, Kurz left Calcutta on leave to visit the Straits Settlements. He reached Penang on the 12th December, but was taken ill and died at that place on the 15th January 1878, at the age of 43 years. An uninterrupted residence in the tropics of 21 years, and constant exposure on his botanical explorations, had undermined his constitution. His ardour in the pursuit of Botany was irrepressible, and he rarely thought of health or comfort on his expeditions.

He was Member of several learned Societies; his fellow Botanists in England, the Continent of Europe and in India will mourn his loss, and by many of his friends outside the circle of those interested in science, he will long be remembered by his enthusiastic and single-minded devotion to the science, which, from early youth, was the aim and object of his life.

Report on the Investigation and Collecting of Plants and Seeds of the India-rubber Trees of Para and Ceara and Balsam of Copaiba.

By ROBERT CROSS.

To the Under-Secretary of State for India.

Grove Street, Edinburgh, 29th March 1877.

Sir,

Respecting the service on which I have recently been employed in the collecting of plants yielding the Para India-rubber of commerce, I now take the liberty to forward a detailed account of my proceedings.

On the 19th of June 1876 I left Liverpool by the "Red Cross" Steamer "Cearense," which, after calling at Havre and Lisbon, sailed direct for Para, which was reached on the 15th of July. This city is situated on the southern bank of the River Amazon, which, at the point where it debouches to the sea, has a breadth of 33 miles. Para is distant 80 miles from the ocean.

The population, numbering about 40,000, are chiefly engaged with the despatch of import and export produce. Everything is very dear, and notwithstanding the reputed fertility of the Amazon valley, *I found that nearly all the necessaries of* life are imported. Thus, butter and fish come from Norway, rice and flour from the United States, while sugar, coffee, and *mandiocca* are brought from the southern ports of Brazil. Import duties are high, and so also are those on produce exported, amounting in some things, such as rubber, to 25 per cent. of the value of the article. The houses are mostly built of mud and roofed over with tiles. The windows are chiefly formed of wood, hinged at the top, and pushed out from below, whence the inmates, unseen, obtain views of the street and passers-by. Throughout the course of the day many of the occupants are invariably congregated behind these window lids.

The great bulk of the citizens go about more ostentatiously dressed than the people of London, the attire considered essential being fine black coat and hat, with snow-white ironed vest and trousers, and fancy French boots. Those who do not con-

form to this style of dress are stared at. Even at the beginning I did not agree with the fashion, and afterwards was farther removed from it by being almost daily bedaubed over with the mud of the *gapós*. Coloured females and slaves may be seen stepping into carriages perfectly loaded with large necklaces and glittering ornaments, and even the families of foreign residents are frequently dressed in the most excessive and extraordinary manner.

The phase of slavery that exists is in so mild a form that it is at first not observed. In very many instances the slaves are allowed to hire themselves out on condition of paying their owners a certain sum of their daily earnings. The whole system is evidently dying out more rapidly than the Government laws enacted for its abolition require it to do.

Merchandise and other effects are removed from one place to another in the old primitive way, thus employing many hands, who earn high wages. Emigrant Portuguese, of whom there are about 5,000, are mostly the carriers, boatmen, and shop-keepers of the place. The supply of water for the city is carted through the streets in barrels, and sold at the rate of three-halfpence per *poto*. The *poto* contains 21 English imperial pints. Within 12 hours after being deposited, the water is found to precipitate a greenish substance amounting to nearly one-fourth the quantity, which is not removed even if filtered through several folds of stout cloth. In the courtyards of the majority of the houses are open cess-pools, which in such a glowing atmosphere may assist in developing much sickness. Dysentery, yellow fever, and various other forms of a typhoid character appear to be permanent, although of late there have been no serious outbreaks, and the place is reported more healthy than formerly. Tetanus and other forms of nervous affections are of frequent occurrence, especially among the native-born population. I have no doubt that Para is far more unhealthy than any city in India. It may not be so naturally, but by a combination of circumstances; such I believe to be the case.

I found on arrival, after considerable inquiry, that the great field for caoutchouc collecting was the province of Para, and

the islands which are scattered over the lower portion of the Amazon River. Chief of these is the Island of Marajo, which is about the size of Holland. A good deal of the rubber from the Rio Negro, Madeira, and other tributaries, appears to come in the form of "negrohead," or *sernamby*, while the Para region seems to produce to a greater extent the finer kinds of smoked biscuit rubber, the preparation of which is attended to more carefully, besides which the Para tree is reported to be a different variety. Its milk leaves no very prominent stain on the hands or clothing, while the milk of some of the varieties of rubber of the Upper Amazon gives a black ink-like mark to the hands and clothes of collectors. Black rubber is stated by some to be deficient in recoil or elasticity. In order to form and establish a collection of plants, and for the purpose of making the various observations on the soil, climate, and mode of collecting and preparing the rubber, it was necessary to obtain a place to live in while so employed. Everyone told me I would experience great difficulty in finding a dwelling, and this proved true. After travelling round Para, and searching for about eight days, I succeeded in hiring a house, but at a very high rate, as the place was large, and adapted for a family with attendants and slaves. However, it was secure, and offered every facility for my various requirements, which was important. My next work was to examine the district where the rubber trees grew. Mr. Henderson, who was known to Dr. Spruce, kindly introduced me to an old rubber collector, called Don Henrique, who undertook to lead the way to the *seringal*, as the rubber locality is termed, but after disappointing me twice, I resolved to lose no more time, and procuring from him the services of a lad as guide, I commenced to inspect the forest. On the 25th of July I made a preliminary journey to the region where the trees were wrought.

The land around Para, including where the city stands, rises from the banks of the river southward in the form of gentle undulations, indented, however, in many places by deep gully-like natural ditches, called *gapós*, which often penetrate for many miles into the interior of this vast forest region, and are filled daily by diurnal tides. To those navigable by canoes or

sailing craft the term *ajarape* is often applied. The intervening land between the *gapós* is frequently flat and moist, and owes its origin first to tidal deposits, and afterwards is raised higher by the decayed remains of successional rank growths of vegetation. On the elevated lands beds of white sand, 20 feet in depth, are met with, covered with a layer of decayed vegetation. At a similar level to this we find a deposit approaching to clay or very fine sand and mud, with here and there masses of sandstone or granite cropping out. In every direction where a view can be obtained, the country is seen to be covered by dense exuberant forest. Leaving Para, I travelled over the high ground for several miles, until the primitive forest was reached, and then went down towards the *gapós*. Following through the wood, a path used by the caoutchouc collectors, we soon came to a large tree in a state of decay, which had been tapped many times. At first sight I felt extremely puzzled and perplexed at the appearance it presented. From the ground up to a height of 10 or 12 feet the trunk was one swollen mass of warty protuberances and knots, covered with thick scales and flakes of hard dry bark.

This singular state of growth, the result of the practised system of tapping, has not yet been recorded by any one, and so was to me unexpected. A few minutes of careful examination soon showed the real cause of these deformities. The collector makes use of a small axe-like implement an inch broad. At each stroke he cuts through the bark and into the wood for fully an inch. Hundreds of these are made in the wood of each tree in the course of a few years, and cannot heal under any circumstances; but a layer of wood is formed over the injured part, at the expense of the bark and general vitality of the tree. The newly-formed wood is again cut into and splintered, and so the process is repeated on each successive layer until the trunk becomes merely a mass of twisted wrinkled wood, with very thin insipid bark. In this condition hardly any milk flows from the cuts; and, although for years a few green leaves may continue to sprout from the points of the twigs, yet the tree may be considered as dead, and, in fact, finally withers away. It is, therefore, the injury

done to the wood, and not over-tapping, which lessens the flow of milk, and ultimately causes the death of the tree. The cuts in the wood are of course unnecessary, since the milk is met with only in the bark. The healing over process which afterwards takes place is similar to that seen where a branch has been lopped from a trunk. The wood is compact and rather hard, and for this reason the tree lives on for a number of years, although cut and hacked every season; but the flow of milk becomes so lessened that many are practically abandoned for years before they die. This and several large adjoining trees were growing in moist deep heavy soil of a fertile character, but quite out of the reach of any inundation.

On the 2nd of August I went in search of plants, and descended to the region of the *gapós*. It had rained a good deal previously, and the collector's footpaths were ankle deep with mud. After wading several little pools, we came to a deep *gapó*, into which the tide flowed. It was connected with many lesser watercourses that formed a kind of network, extending over a wide district of forest-covered country, the more elevated parts of which were raised only from three to four feet above the highest tides. A considerable number of rubber trees grew along the margins of both the larger and smaller streams, intermixed with cacao and forest trees. Three were observed, the base of the trunks of which were flooded to a height of one foot, yet the roots seemed to run up to the brow of the bank, and no matted rootlets were observed, as is the case with the willow tree when growing on the margin of a rivulet. Most of the others occupied dry situations. Those *gapó* ditches were lined with soft rich mud, without doubt possessing great fertility. The exhalations from such places, shrouded by a forest growth of 80 or 100 feet high, were sensibly felt, and on nearly every occasion when I visited those localities I experienced slight attacks of fever afterwards. The collectors, also, during the working season are often indisposed from the same cause. Although the forest was excessively damp, yet tapping was being carried on, as a man was seen mixing up some clay at the side of a *gapó*.

A number of good plants were met with beneath the oldest trees. The seedlings did not usually grow in any place where the ground was covered by more than two or three inches of water at flood tide. However, by far the greatest number were met with on sites above the reach of the highest tides. I measured a few of the largest trees, all of which had been tapped for periods varying from 5 to 15 years. Those found growing in shallow *gapó* ditches are preceded by an asterisk. The circumference of each one yard from the ground was as follows :—

	Ft.	In.		Ft.	In.
No. 1	.. 6	9	No. 7	.. 4	0
No. 2	.. 6	10	No. 8	.. 5	10
No. 3	.. 4	7	No. 9	.. 4	0
No. 4	.. 3	0	No. 10	.. 4	6
*No. 5	.. 5	10	No. 11	.. 4	8
No. 6	.. 5	8	*No. 12	.. 2	8

Most trees occurring within the limits of the worked districts are tapped if possessing a diameter of six or eight inches. Regularly-tapped trees, as a rule, do not exceed 60 feet in height.

August 7th.—I went in search of more plants, and on the 10th made another collection. About 2,000 in all were obtained, but a number had to be rejected. I had cases previously made, so that I was able to plant the plants in them without delay. The soil consisted of decayed leaves brought from the forest. The rougher portion was charred and put in the bottoms of the cases to serve as a sort of drainage. Then a layer mixed with some wood ashes was placed above the plants planted therein. Four cases, containing upwards of 1,000 plants, were finished in this way, one being reserved for copaiba or any other sort of rubber plants I might meet with. While the plants were being established I commenced a series of experiments, in order to ascertain how the tree might be readily multiplied in a simple rough way by any person not specially acquainted with the principles of propagation. Two separate beds, the one of brown sand, the other of decayed leaves, were formed. The terminal portion of

shoots, but with a bud at the lower end, were planted in the beds in a reclining position, with only two inches of the points above the ground. Owing to the great distance between the buds, consequent on vigorous growth, many of the cuttings were a foot or more in length. At the same time a number were set deeply in an open vessel containing only rain water. The cuttings in the sand bed were the first to grow, and soon made strong shoots and root fibres. Those in the leaf mould pushed more slowly, but developed green leaflets of great substance. The cuttings placed in the water had a small portion of tap root at the base, as the object was to determine if the roots would actually develop in water alone. Within fourteen days these plants had several roots formed, and one or two rather weak growths came up, but a few days after I had thrown into the water some burnt earth and wood ashes the increase in vigour was very apparent. After these experiences I felt convinced that the Para rubber tree delights in abundance of moisture and rich fertile deposits.

Method adopted in tapping the trees.—When the plants were somewhat established, I resolved to examine attentively the process of tapping as practised by the caoutchouc collectors. In the investigation of this subject I travelled over a very wide extent of flat forest country, much divided by miry hollows and tidal *gapós*, which stretched along the bank of the river Guamà. Although this river is at least three times as broad as the Thames at London Bridge, it is not to be seen on any ordinary map. In the region alluded to there were hundreds of trees wrought by different collectors, each of whom had a separate piece of land to work on. When on these excursions, I had to go away from my place of abode at about three o'clock in the morning, as I had some miles to travel over paths not always in good condition, and it was necessary to be as near as possible to the spot where the tapping operation was performed, because the collectors begin to work immediately at daybreak, or as soon as they can see to move about among the trees. They say the milk flows more freely and in greater quantity at early morn. I do not attach

much importance to this statement, but I have recorded it. Another and more probable reason is, that as rain often falls about two or three o'clock in the afternoon, the tapping must be done early, as in the event of a shower the milk would be spattered about and lost. The collector, first of all, at the beginning of the dry season, goes round and lays down at the base of each tree a certain number of small cups of burnt clay. At the lesser trees only three or four are put, but at the larger ones from eight to twelve are deposited. The footpaths leading from tree to tree are likewise cleared of sapling growths, and the bridges over the *gapós* formed at each place by the trunk of a tree are, where necessary, replaced. On proceeding to his work the collector takes with him a small axe for tapping, and a wicker basket containing a good-sized ball of well-wrought clay. He usually has likewise a bag for the waste droppings of rubber, and for what may adhere to the bottoms of the cups. These promiscuous gatherings are termed *sernamby*, and form the "negro-head" of the English market. The cups, as already stated, are of burnt clay, and are sometimes round, but more frequently flat or slightly concave on one side, so as to stick easily when with a small portion of clay they are pressed against the trunk of the tree. The contents of 15 cups make one English imperial pint. Arriving at a tree, the collector takes the axe in his right hand, and, striking in an upward direction as high as he can reach, makes a deep upward sloping cut across the trunk, which always goes through the bark and penetrates an inch or more into the wood. The cut is an inch in breadth. Frequently a small portion of bark breaks off from the upper side, and occasionally a thin splinter of wood is also raised. Quickly stooping down he takes a cup, and pasting on a small quantity of clay on the flat side, presses it to the trunk close beneath the cut. By this time the milk, which is of dazzling whiteness, is beginning to exude, so that if requisite he so smooths the clay that it may trickle directly into the cup. At a distance of four or five inches, but at the same height, another cup is luted on, and so the process is continued until a row of cups encircle the tree at a height of about six feet from the ground.

Tree after tree is treated in like manner, until the tapping required for the day is finished. This work should be concluded by nine or ten o'clock in the morning, because the milk continues to exude slowly from the cuts for three hours or perhaps longer. I may state that there is a great difference among collectors in the performance of those duties. Some take care to get good clay previously and incorporate it well, so that a very small portion is needed to lute the cups to the trunks; they also work with neatness and intelligence, and invariably collect a good quantity of milk. Others, again, do not take the trouble to prepare clay beforehand, but merely scrape up a handful when they require it at the side of a *gapó*, which is often of little consistence, so that a large quantity is required to fasten the cups. This class of collectors have often many fragments of clay or other impurities in their milk, the result of not following a proper method of working. The quantity of milk that flows from each cut varies, but if the tree is large, and has not been much tapped, the majority of the cups will be more than half full, and occasionally a few may be filled to the brim. But if the tree is much gnarled from tapping, whether it grows in the rich sludge of the *gapó* or dry land, many of the cups will be found to contain only about a tablespoonful of milk, and sometimes hardly that. On the following morning the operation is performed in the same way, only that the cuts or gashes beneath which the cups are placed are made from six to eight inches lower down the trunks than those of the previous day. Thus each day brings the cups gradually lower until the ground is reached. The collector then begins as high as he can reach, and descends as before, taking care, however, to make his cuts in separate places from those previously made. If the yield of milk from a tree is great, two rows of cups are put on at once, the one as high as can be reached, and the other at the surface of the ground, and in the course of working, the upper row descending daily six or eight inches, while the lower one ascends the same distance, both rows in a few days come together. When the produce of milk diminishes in long wrought trees, two or three cups

are put on various parts of the trunk, where the bark is thickest. Although many of the trees of this class are large, the quantity of milk obtained is surprisingly little. This state of things is not the result of overtapping, as some have stated. Indeed I do not believe it is possible to overtap a tree if in the operation the wood is not left bare or injured. But at every stroke the collector's axe enters the wood, and the energies of the tree are required in forming new layers to cover those numerous wounds. The best milk-yielding tree I examined had the marks of twelve rows of cups which had already been put on this season. The rows were only six inches apart, and in each row there were six cups, so that the total number of wood cuts within the space of three months amounted to seventy-two. It grew close to a *gapó* only eight inches above high-tide mark, and being a vigorous tree, the cups were usually well filled, but with two years or so of such treatment the tree would probably be permanently injured. It has been supposed that the quality of the milk is better in the dry season than during the rains. Such is the case with some vegetable products; but, as regards India-rubber, there ought not, I think, to be any appreciable difference. In the rainy season the milk probably contains a greater proportion of water, but, on the other hand, I am of opinion that then a larger quantity of milk flows from the tree. No doubt the dry season is the most suitable for caoutchouc collecting, although, wherever a plantation is formed with preparing house, convenient tapping may certainly be always carried on when the weather is fine. It is a common report that the trees yield the greatest quantity of milk at full moon. In order to ascertain this, a number of very careful experiments would require to be made, extending over one or two years. Even if such an assertion was found to be true, it would probably make little difference, as tapping will have to be carried on when circumstances are most favourable.

There are two other methods adopted in tapping, which are chiefly confined to the Upper Amazon and tributaries. Both are exactly on the same principle, the materials used being only a little different. The loose outside bark of the tree

is cleaned off to a height of about three feet. Beneath, a gutter or raised border of clay is pasted or luted to the trunk, enclosing one-half or the entire circumference. Cuts are thickly made in the bark above this, from which the milk flows down to the gutter, whence it is conveyed to fall into a calabash conveniently placed. The other mode is by winding round the trunk the stout flexible stem of a climber, and claying it round securely so that no milk may escape between the trunk and the climber. These plans are not extensively adopted, and can only be successfully put in practice where the trees have not been previously tapped. There is always a great deal of "negro-head," the result of the distance the milk has to run, and to the large quantity of clay employed in the process.

Collection of the Milk.—Going from tree to tree at a sort of running pace, the collector empties the contents of the cups into a large calabash, which he carries in his hand. As he pours the milk out of each cup he draws his thumb or forefinger over the bottom to clean out some which otherwise would adhere. Indeed, a small quantity does remain, which is afterwards pulled off and classed as *sernamby*. The cups on being emptied are laid in a little heap at the base of each tree, to be ready for the following morning. The trees occur at various distances from 10 to 100 yards apart, and as I travelled over the intricate network of muddy footpaths, I continually felt perplexed and surprised that the natives have not yet seen the advantages that would be derived by forming plantations, whereby more than twice the quantity of caoutchouc might be collected in one-fourth the time, and at far less cost and labour.

Method of preparing the Rubber.—The collectors of the region I visited, resorted with their milk to a large shed situated on the bank of the river Guama. Here were quantities of various species of palm nuts, representing an *Attalea* and *Euterepe edulis*, stored in heaps, and several jars for the preparation of rubber. These jars were 18 inches high, and the bottoms were broken out. At the base they were 7 inches

in diameter, bulging out in the middle to 12 inches, and were narrowed at the mouth to a breadth of 2 inches. Each person wrought on his own account, and so small jars were employed, but where a number of men are collecting for one master much larger jars are in use. The milk, on being put into a large flat earthen vessel, is put down on the floor in a convenient place. Adjacent thereto the jar is set on three small stones, which raises it to 1½ inches above the floor. The narrow space between the base of the jar and the floor allows the air to enter, which causes a current of smoke to ascend with remarkable regularity and force. When the fire commences to burn strongly, several handfuls of nuts are put on, then some more wood and nuts alternately. These are dropped in at the mouth of the jar until it is filled to within four inches of the top. Due care is taken that a sufficient proportion of wood is put in with the nuts. The mould on which the rubber is prepared resembles the paddle of a canoe; in fact, at many places on the Amazon this is the article most frequently used if there is much milk, and when the rubber is prepared in bulky masses. Occasionally the mould is slung to the roof, as the weight in handling it during the process would otherwise be very fatiguing. A little soft clay is rubbed over it to prevent the rubber from adhering, and it is afterwards well warmed in the smoke. The operator holds the mould with one hand, while with the other he takes a small cup and pours two or three cups of milk over it. He turns it on edge for a few moments above the dish until the drops fall, then quickly places the flat side two inches above the jar mouth, and moves it swiftly round, as if describing the form of a cipher, with his hand, so that the current of smoke may be equally distributed. The opposite side of the mould is treated in the same way. The coating of milk on the mould on being held over the smoke immediately assumes a yellowish tinge; and, although it appears to be firm on being touched, is yet found to be soft and juicy, like newly-curdled cheese, and sweating water profusely. When layer after layer has been repeated, and the mass is of sufficient thickness, it is

laid down on a board to solidify, and in the morning is cut open along the edge on one side and the mould taken out. Biscuit rubber, when fresh, is often four or five inches thick. On being hung up to dry for a few days, it is sent to market. When I saw the process of smoking the rubber performed, as just described, I was considering the statements of Keller and other travellers who write on this subject, all of whom seem to believe that the smoke from the palm nuts possesses some peculiar or strange property by which means the milk instantly coagulates. But on one occasion, when the collector was commencing to smoke some milk, I saw him wait for a short time, during which he put his hand repeatedly to the mouth of the jar, and soon learned that he could do nothing until the smoke was hot. The dense white smoke rose abundantly, but the milk would not thicken on the mould. After a little while the jar became heated, and the operation went on quite satisfactorily. I put my hand above the mouth of the jar, but could not bear the heat scarcely a second; and, although the temperature of the smoke was apparently less than boiling water, yet I judged it must have been at least 180° Fahrenheit. Therefore the rapid coagulation of the milk is simply produced by the high temperature of the smoke. I have no doubt that, with a strong current of heated air, or a good pressure of steam from a pipe, a similar result would be obtained. The finely divided particles of soot which forms a large proportion of the smoke, undoubtedly absorbs a considerable amount of moisture, although at the same time it must be looked on as an impurity. I have no hesitation in giving my opinion that equally as good rubber could be prepared by putting the milk in shallow vessels, and evaporating the watery particles by the heat of boiling water.

Temperatures of the Para Rubber District.—I now proceed to give the temperatures taken during my stay in the region of Para. According to the natives the rains begin in November or December and end in June. However, during the intervening months of summer it will be seen that showers of rain are frequent. These usually occurred between two and three o'clock in the afternoon, and streamed down with a force

similar to the monsoon showers in India. The days on which rain fell are preceded by an asterisk.

1876.	Morning.	Noon.	Night.
	°	°	°
July *17	—	88	81
,, *18	79	88	81
,, 19	80	87	83
,, *20	79	86	79
,, *21	79	87	79
,, 22	77	86	85
,, *23	79	87	83
,, 24	79	87	85
,, *25	79	89	83
,, 26	79	87	84
,, 27	80	87	84
,, *28	79	88	81
,, *29	77	89	83
,, *30	81	90	84
,, *31	80	86	82
August 1	79	80	79
,, 2	77	80	83
,, 3	78	87	85
,, 4	79	87	83
,, *5	79	89	83
,, *6	79	87	84
,, 7	77	86	83
,, 8	80	88	84
,, *9	80	88	83
,, 10	79	89	84
,, *11	78	87	82
,, *12	80	88	80
,, *13	79	87	82
,, 14	77	84	81
,, 15	77	87	82
,, *16	77	85	81
,, 17	78	88	84
,, 18	79	88	83
,, *19	78	88	82
,, *20	78	87	81
,, 21	79	88	83
,, 22	77	89	82
,, 23	78	89	82
,, *24	77	88	82
,, 25	79	87	81
,, 26	77	86	84
,, 27	78	87	83
,, *28	79	85	81
,, *29	76	87	82
,, *30	77	86	81
,, *31	78	87	82
September *1	76	86	83

1876.	Morning.	Noon.	Night.
	°	°	°
September 2	78	86	84
,, 3	73	89	85
,, 4	84	92	83
,, 5	82	91	81
,, *6	73	90	83
,, 7	73	91	81
,, 8	76	89	81
,, 9	76	88	83
,, 10	75	90	77
,, *11	76	89	83
,, 12	75	89	81
,, 13	74	88	82
,, 14	75	87	81
,, 15	76	89	83
,, *16	75	90	81
,, 17	74	88	84
,, *18	73	87	81
,, 19	74	87	83
,, 20	73	89	80
,, 21	74	88	83
,, 22	73	89	83
,, 23	75	91	82
,, 24	76	90	84
,, 25	75	87	83
,, 26	74	92	81
,, 27	75	92	84
,, 28	74	93	85
,, 29	75	92	83
,, 30	76	92	85
October 1	74	91	84
,, 2	74	92	85
,, *3	75	91	84
,, 4	74	87	82
,, 5	76	90	84
,, 6	75	89	85
,, *7	74	88	84
,, *8	75	89	83
,, *9	74	88	82
,, 10	76	87	84
,, 11	75	89	83
,, 12	75	88	84
,, *13	76	87	84
,, 14	74	89	83
,, 15	75	90	84
,, 16	75	90	82
,, 17	75	89	85

A glance at these figures will show that the region of the Para rubber tree has a sustained high temperature—a fact which has already been remarked by Dr. Spruce and other travellers. The lowest I could record was 73°, but Mr. Henderson assured me he had frequently seen it down to 72°, and I have the statements of another observer, on whom I coulp

rely, that on one occasion the thermometer fell to 65°. The place, however, where this observation was made was fully 100 miles to the westward of Para. In the neighbourhood rubber trees abounded.

Sites, propagation, and planting in India. -The sites most suitable for the planting of this tree will be found in the hottest parts of India. The flat, low lying, moist tracts, lands subject to inundation, shallow lagoons, water holes, and all descriptions of mud accumulations, miry swamps, and banks of sluggish streams and rivers, will be found best adapted. The tree will also grow perfectly in deep humid land, fitted for cane or coffee planting. The Malay Peninsula, Burma, the island of Ceylon, and the southern portion of India on to about as far north as 20° north latitude, should possess many localities proper.

The temperature of rain-water varied from 74° to 75° for planting ; but in no place would I recommend the formation of a plantation where the thermometer at any time falls below 60° Fahrenheit.

It seems to me that the propagation and planting may generally be combined in one operation, the object being to reduce the expense, simplify and accelerate the work, and promote the more perfect development of the primary roots and trunk. The green coloured terminal shoots of succulent growth, with the leaves fully matured, make the best cuttings. These should be cut off low enough, so that there is a joint at the base. When it is desirable to plant in dry firm land, a spadeful of soil should be turned over at each place, and the cutting planted in a sloping position. It should oe covered with mould to within three inches of the point. That portion above ground should rest on the earth on one side to its termination, so as not to suffer during hot sunshine. In all stages the crowns of the plants may be exposed to the rays of the sun. Plants intended for cutting stocks may be planted in open places, in the richest dark loam capable of producing a luxuriant rank crop of sugar cane. Seeds might be planted out permanently at once, also in the same way as the cuttings. These would prosper much better if at the time of planting

a handful of wood ashes were added to the soil with each seed. Good ashes may be obtained by the burning of any description of green wood or newly felled piece of forest. If the wood is allowed to rot before burning almost the whole of the fertilizing principles will be found to have vanished. If stored in a damp place the value of the product is diminished. For planting on inundated lands the period of high flood should be preferred. Cuttings of greater length would be required in this case, the lower ends of which should be sliced off in the form of a wedge. The workman could take a bundle of these, and wading into the water would plant at proper distances, but perfectly upright, taking care to push each cutting down deep enough in the soft muddy bottom, so that not more than three or four inches is above the surface of the water. The same rule would be applicable when planting in sludge or soft marsh land. The crowns of the cuttings must not, if possible, be put under water, as the young growths springing therefrom might rot. Seeds will not be found very applicable for planting in watery places or deep mud deposits. Some would come up, but a good many would mould and decay. In the varied course of circumstances and conditions, slight changes and modifications in the methods of working will no doubt suggest themselves. I would not advocate, at least for the present, the extensive planting of this tree in fertile cane-producing lands, because in such a description of soil it would not be able to compete with the Central American rubber tree, already introduced from the State of Panama, which grows rapidly to a much greater size, and yields a far larger quantity of caoutchouc. It should rather be planted in places where nothing else could be profitably cultivated, such as frequently inundated river margins, marsh land, and mud deposits. Above 4,000 tons of Para rubber are exported annually.

Search for plants of the tree yielding the Balsam of Copaiba, Capivi of commerce.—I was recommended by Mr. Markham, just before leaving, to endeavour to obtain at Para some plants of this tree, which abounds in the forests of the Amazon valley. These balsam trees have a wide distribution, and are

likewise found dispersed in the forests of Guana and Venezuela, and in the wooded littoral districts of New Granada, especially in the States of Santa Martha, Carthagena, and Panama. In those regions different species of trees varying in size and yield, furnish balsam, but all are leguminous, and belong to the genus *copaifera*. The finest sort in commerce, called by the collectors white copaiba, is met with in the province of Para, and is shipped from Para and Maranham. Very large quantities are annually sent to the French market.

After protracted inquiry I discovered that few people really knew the tree, and I was beginning to think that I might not be able to obtain any knowledge of it, when fortunately I learned where a practical copaiba collector lived. Formerly the tree might be seen growing in places easy of access, but owing to the method of collection practised it is now comparatively rare. At present a collector must make a journey, occupying several weeks, in a canoe up some of the Amazon tributaries, or penetrate into the dense forest lying between the rivers, to find any considerable quantity of copaiba.

It cost me three successive journeys on foot, occupying three days, before I could arrange with the collector. He was drinking a supply of cane rum (*cachass*), and he would not go anywhere until it was finished. Few occupations are so perilous and fatiguing as that of the balsam collector. Exposed daily to the drenching rains in the depths of the forest, with often an insufficiency of food, bitten by large formidable ants, and tormented unceasingly by day and night by swarms of mosquitoes, his life is of a wretched description. When living under these conditions the smallest scratch from the underwood is apt to become a sore, and increase to the size of a florin in forty-eight hours. On the 17th of September I left with the lad, and joined the collector at the entrance to the forest. The path led through a dense lofty vegetation, the majority of the trees being from 80 to 100 feet in height. The extremely fertile soil was of soft white sand, 20 feet or more in depth, covered by a thick surface layer of vegetable mould with which the sand was intermixed. Slight undulations were traversed, and three little running streams were

crossed, none of which contained more than a mill of water. The land was everywhere quite mealy and dry, and was elevated at least 50 feet above the region of the *gapós* or tidal floods. Large black ants, some of which were nearly two inches in length, called by the natives *candela*, ran over the ground everywhere. The bite of this ant is quite as painful as the sting of a wasp in this country. After travelling several miles we came to a balsam tree of gigantic dimensions. The saplings had been cut down around it by a person who lived some distance away, and who consequently was considered the owner. The tree appeared to be 80 feet in height, with a clear trunk of 50 feet. On account of the great thickness of the trunk, and absence of branches, no one was able to climb it. The clearing away of the underwood admitting freely air and light had induced the tree to bear seed, which, however, was just beginning to ripen. Little perpendicular rents were observed in the bark of the trunk from eight inches to a foot in length. From some of these, which had occurred quite recently, a little balsam had exuded, and flowed down the trunk. A diligent search for plants was made, and one small seedling was found by the collector, which I rejected, as I doubted whether it was really a balsam plant. Without much loss of time we continued our journey along a narrow path lined with tall grass and shrubs. At mid-day we came to some copaiba trees, one of which had been tapped some years ago. It had a massive lofty trunk, and wide spreading crown, and must have borne many crops of seeds, but not one plant was to be met with. A further search beneath a number of other trees which were scattered about proved alike fruitless. The collector explained that the seeds on falling were immediately eaten up by an animal about the size of a rat. This fact fully accounted for the scarcity of seedlings. Everywhere underneath the trees a close network of little paths traversed the ground. We penetrated this day into the forest for a distance of 12 or 14 miles, and got neither plants nor seeds. I had a little fever afterwards for about a day, which, although mild, weakened me considerably. I felt that the daily exposure in the sun afterwards fed the symptoms which remained.

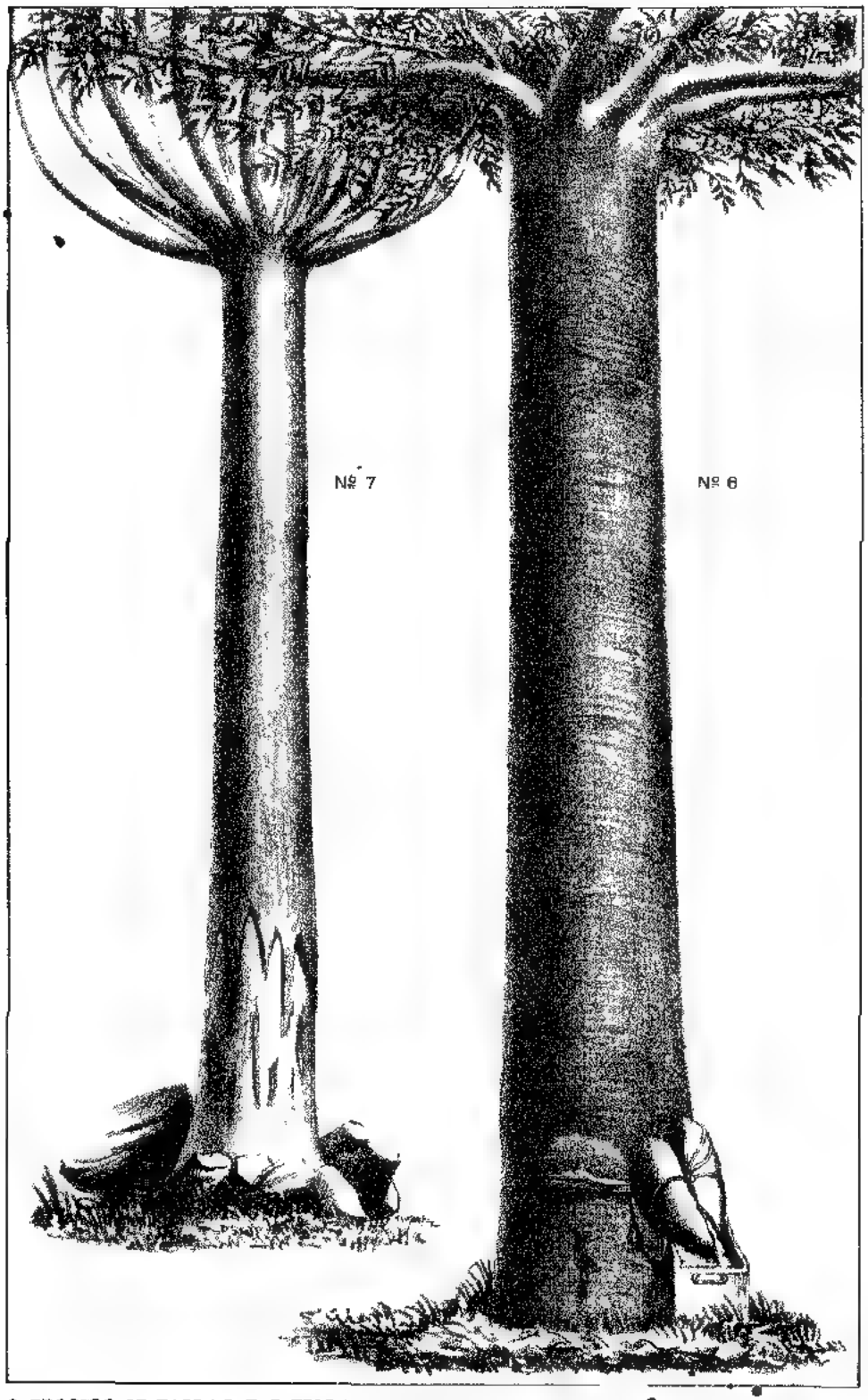
On the 9th of October I took with me the lad, and returned to *examine the copaiba tree in fruit already noticed*. A number of capsules were found beneath it, but all were empty. The ground was thickly covered with the little paths of the animal which had devoured the seeds. Whilst engaged in searching about a gentle breeze of wind arose, which, moving the branches, brought down a few seeds in the best possible condition. These were carefully gathered, and in all 18 seeds were collected. Each little pod contains only one seed, which is coated over with a white wax-like substance, possessing a delicious aroma. When this is removed the seed is found to be black, and about the size and form of a field bean. The time was at hand when I purposed to leave with the rubber plants, so as to get to England before the cold weather set in, but I resolved, if possible, to see the method of tapping the trees actually performed. *This operation has not yet been* accurately described by any traveller, and no scientific work or class book in the English language gives a correct account of the process, for which reason I take the liberty of recording my observations.

Early in the morning of the 13th October I proceeded to the forest, accompanied by the lad and the copaiba collector. To each was assigned a fair travelling load, consisting of food or other necessities, but the most prominent object was a large tin capable of holding about 40 English pints, which the collector carried on his back. We travelled by a path to a point beyond the place reached on a former occasion, and then diverged into the forest, where there was no track of any kind. Entering on a district where the trees were an amazing height, we in a short time came to a very large copaiba tree. This, and a number of others, were previously known to the collector, who tapped one or two when convenient. I found he did not want the lad to see the largest of these trees, lest he might show them to others. On reaching the tree, he struck the trunk two or three blows with the handle of his axe, when a sort of hollow sound was produced. The grand symmetrical trunk was clear of branches to a height of at least 90 feet, above which the crown spread out flatly, the slender interlaced boughs, clothed

with little pinnate foliage, forming an agreeable shade from the rays of the sun. The circumference at 3 feet from the ground was 7 feet 2 inches. Several old fissures in the bark were observable, and one, which had occurred quite recently, was nearly 5 feet in length. Very little balsam had exuded. These rents are reported to be occasioned by the accumulation of oil in the tree, and that when they happen a loud report is heard.

The person who successfully taps a copaiba tree must be a skilful axeman. A chamber or cavity is cut in the trunk, not much broader than the axe, but sufficient to allow the workman to vary the course to the heart of the tree in such a way that he may not miss what is termed the "vein" or channel, usually met with near the centre, from which the balsam flows. The base or floor of the chamber must be carefully and neatly cut with a gentle upward slope, and it should also decline to one side, so that the balsam on issuing may run in a body until it reaches the outer edge. Below the chamber a pointed piece of bark is cut and raised, which, enveloped with a leaf, serves as a spout for conveying the balsam from the tree to the tin.

The collector commenced the work by hewing out with his axe a hole or chamber in the trunk about a foot square, at a height of two feet from the ground. The wood at first was white to a depth of four or five inches, when it changed to a purplish red, very much resembling a piece of old oak taken from a peat moss or bog. The whole of the interior of the tree is of this colour. When the centre appeared to be reached, I was about to remark that there was no balsam, when suddenly the collector laid down his axe and called hastily for the tin. The balsam now came flowing in a moderate sized cool current, full of hundreds of little white bubbles possessing a pearly transparency. At times the flow stopped for several minutes, when a singular gurgling noise was heard, after which followed a rush of balsam. When coming most abundantly a pint jug would have been filled in the space of one minute. Owing to the diminished light consequent on the thick masses of foliage overhead, I could not distinguish



6 PROCESS OF TAPPING THE TREE YIELDING BALSAM OF COPAIBA

7 CEARÁ INDIA RUBBER. REPRESENTING THE SURFACE BARK OF THE LOWER PORTION OF THE TRUNK PARED OFF AS PRACTISED BY THE COLLECTORS IN BLEEDING THE TREE

the "vein" in the heart of the tree, but I observed a number of fissures that appeared to radiate from the centre outwards. Whilst making these observations I was surprised to see that the whole of the wood cut through by the axeman was bedewed with drops of balsam, and so also were the ends of the chips. This remarkable and important fact shows that every atom of wood in the tree contains a certain amount of copaiba. The bark did not appear to possess a particle. In the course of an hour nearly one-fourth of the tin was filled. A little roof, thatched with leaves, was placed over it as rain began to fall heavily. We then returned home. The collector considered the tin would be filled, and proposed to return for it in a couple of days. Although balsam may be seen slowly dropping from a tapped trunk for a month after it has been operated on, the common practice is to allow a tree, if it be good, only two or three hours to drain, and then to proceed to another. Occasionally large trees are met with which when tapped yield little balsam. The cause of this has not been ascertained. Trees of the largest size in good condition will sometimes yield four "potos," equal to 84 English imperial pints. A collector, where trees are abundant, and with plenty of vessels, can, it is said, make at the rate of 5*l.* per day. Mr. Clough, an English missionary, in describing in a recent work* the method of collecting balsam, says that it "is obtained by making a gash in the bark of the tree, and plugging the space with cotton, to absorb the juice which exudes." I will venture to state that not a drop would be obtained by this process. Nor is the practice, as stated by some, of closing the cavity cut in the tree for a time with clay or wax, to allow the balsam to accumulate, ever resorted to. Even if tried it would not answer, for a number of reasons. Balsam, as it comes from the tree, has a powerful pungent fragrance, which is not particularly disagreeable, although on passing the doors of the houses where it is stored at Para an odour, by no means pleasant, is experienced. Possibly some change may take place in keeping. Little, if any, care seems to be taken

* "The Amazon: A Twelvemonth's Tour," by S. Clough.

to preserve the commodity pure. Those who go up the rivers to collect on a large scale take in their boats all descriptions of jars and barrels which may have been imported with liquors, grease, or any kind of article. Paraffin cans are special favourites, and so are much sought for. Most of those vessels, on being emptied, are stowed away in dusty places, uncorked and uncovered, thus affording free ingress to ants, spiders, and all classes of insects. It is urged by some that balsam precipitates all impurities, but even if this were so, a better system might be adopted. As some of the seeds brought home have germinated at Kew, I may add a few remarks regarding the cultivation in India, whether a few plants should be sent when strong enough for removal. I trust care may be taken at Kew to keep this sort separate from other species cultivated there, mostly natives of the West Indies, and which, although interesting in what may be termed a "botanical sense," are of no value for the production of copaiba. The temperature required is the same as that for the Para rubber tree, which at times is found growing beside it. Wet or marsh land must be avoided. The site should be of the best dry loam, suitable for cane or coffee planting. The stock for planting will have to be obtained from seeds ripened in India, so that, if a few plants can be transferred thither, they should be planted in good situations, where plenty of sunshine is admitted, in order that seed may be early produced. Seedlings may be planted tolerably thick, so as to shoot rapidly up, when they can be thinned out to proper distances.

I would not recommend the planting of these trees on a large scale with a view to early profit, as the growth would be slower than Panama or Para rubber trees. The return would, I think, be realized in about the same time as is the case with oak plantations. However, a few hundreds of copaiba trees growing on a planter's estate ought to enhance the value of it. Apart from the medicinal value of copaiba, it might be well to ascertain if it would not be equal to castor oil for lubricating machinery. The journeys relating to this work were among the most fatiguing I have experienced in these countries.

Examination and collection of seeds and plants of Ceara

India-rubber.—On the morning of the 26th I went on shore at Ceara, as I wished to gain some knowledge of the method adopted in the preparation and collection of the rubber exported from Ceara. I had to land from the ship in a *jangada*, which is a raft 12 or 14 feet in length, formed of moderately-sized trunks of a tree fastened together, and furnished with a mast and large sail. A piece of board, a foot in breadth and four feet long, is pushed down in the middle between two logs, to serve as a keel. The tree selected for those rafts has a peculiarly light wood said to be brought from Bahia or Pernambuco. With a good fair wind they are said to run sometimes at the rate of 15 knots an hour. The surf is so strong that no boat or canoe could often reach the shore safely. Even the *jangadas* are sometimes overturned, and when this happens there is a risk in getting a blow from the timbers of the raft—a danger considered greater than the sea. In the town I saw a large quantity of rubber in a merchant's store, and afterwards observed that it was freely traded in by most classes of shop-keepers. I expected to have seen the tree yielding it somewhere near, but after travelling about over the sand-hills and adjoining country for the greater part of the day, I returned to the ship completely tired. I was assured by a native, who said he knew the Para rubber tree and that of Ceara, that both were completely identical. But the great diversity in the climate induced me to think different, and so I resolved to follow out the dictates of my own judgment, and not be influenced by any one until I could satisfy myself on the matter. Yet there was little time to explore, as the steamer was expected to leave in a very few days. Next morning an Indian from the interior happened to come on board the ship, and I took the opportunity of asking him the names of some of the villages and localities in the retired districts. I knew from previous travelling a good number of the Indian substantives, with their meanings, and this, together with further conversation, enabled me to form some idea of the character of the region where the rubber was collected. A single line of rail, formed to facilitate the transport of sugar and cotton, runs from Ceara into the interior to a place called

Pacatuba, distant about 40 miles. Contiguous are a number of large plantations with some slaves. On Sunday, October 29th, I landed with the *jangada*, and proceeded through the town to the railway station. I had previously arranged with a native to accompany me, but he did not appear, so I went off alone. Leaving Ceara, a flat parched-up region was traversed, diversified by a few undulations and moist hollows. Thorny thickets of bushes and slender trees, chiefly myrtles and legumes, overspread the country, with many groups of the Carnaúba palm, (*Copernicia cerifera*,) rising high above the ordinary vegetation. The crowns of these palm trees waved about by the wind and visible over such a wide expanse presented an appearance extremely picturesque, whilst in the distance beyond rose a multitude of conical peaks and mountains, the whole combining to form a landscape of surpassing beauty. After a journey of two hours I stopped at a little village with about a dozen thatched houses, called Maracanahu. The distance may be 30 miles from Ceara. I went to a man and boy who were standing in front of a hut, and made some proposals to them to show me the locality where the rubber trees grew. The man was advising the boy to accompany me, who seemed rather reluctant, when a poor lad, who had lost an arm, came up and at once consented to go with me. It was fortunate I met with this one-armed lad, as I could hardly have succeeded so well with any one else. I told him I wanted first to see trees that were being wrought, because I wished to make sure of the tree, and also observe the method of collection. We proceeded along a dusty path for some distance, at times running, as I proposed, if possible, to return with the train which passed the village in the evening. Plantation establishments were seen dispersed at wide intervals over the country. Cultivation was only carried on in very low moist situations, or where the water during the rains was stored up in artificial ponds for irrigation. Some of these were so large that at first I took them to be natural lakes. After travelling for some time the lad turned from the path and dived into the forest. In a few minutes he brought me among a number of rubber trees which had recently been bled. The general forest was toler-

ably high, but the sparse small foliage did not afford much shade from the fierce rays of the sun. The soil was in places a sort of soft sandstone or gravel, which was bound up in the most extraordinary manner. Neither grass nor weeds grew among the underwood, and there was an entire absence of ferns, mosses, and other plants. I soon saw that the tree was totally different from the rubber tree of Para, and also that it would probably thrive perfectly over a very wide extent of the drier regions of India. At first sight it much resembles in appearance a birch tree, and the surface or epidermis of the bark comes off in the same way in thin silvery peelings. The largest of the trees were about 50 feet in height, with trunks nine inches to a foot in diameter. The crown is divided into many branches, which grow in the form of a basket. The tree is deciduous, and there were neither leaves, flowers, nor fruit to be seen. I spent some time in examining attentively the process of bleeding the trees, and then commenced to search for plants. A few were found growing in an open space, but the roots were so firm that not one could be pulled up. It seemed strange that the lad and myself, exerting all our strength, could not pull up a young seedling plant about two feet high. I went and got a pointed branch of a hard wood tree,* and scraped and dug about the roots, and in this way, with very arduous work, during which I hurt and lacerated my hands, some plants were got up. The real difficulty was now apparent. The roots of the plants were furnished with tubers, the largest of which were about the size of kidney potatoes. These tubers, although quite near the surface, adhered with such tenacity to the sandstone, or hard gravel, that most of them had to be smashed in order to get away an uninjured portion of root with the stem. In the young state they are soft and spongy, and are seen to contain milk, but afterwards become lengthened out, and form a part of the root. With diligent search and hard labour we succeeded in collecting 18 plants. At the station, a number of natives from Ceara gathered round the "bundle of sticks," but could not make out

* It seems strange that Mr. Cross should have gone out without tools.—Ed.

what they were. However, an old man from the forest district came up, and, peering through the crowd said, "Manisoba." This is the Indian name of the rubber tree, which I knew before. I got back to Ceara just before dark, and fortunately found a *jangada,* which put me on board. Thus in one day I was fortunately able to discover the origin of a tree, hitherto unknown and undescribed, yielding an important article of commerce, and at the same time resolved the mode of collection and preparation, and secured a number of plants. It is true I had no instructions regarding this Ceara rubber plant, probably because it was supposed to be the same as the Para tree. But I thought it would be well to secure more plants, and told the owner of the *jangada* to come for me in the morning. This sort of raft was expensive; each voyage cost me three *milreis* (6*s.*), and I could not possibly have got one for less. The distance was only about three hundred yards. Next day the sea was very rough, and three *jangadas,* one of which carried the Brazilian Government mails, were overturned in the surf. The person I arranged with came for me, and I embarked. Although I was not in the least alarmed, the size and violence of the waves completely surprised me, while the *jangada* at full speed went groaning through the surf, covered by nine inches or a foot of water. I cannot help wondering that not a farthing has been spent in improving the safety of these Brazilian ports.

Returning to Maracanahu, I proceeded to an adjacent house, where I was previously told I could stay. The son of the owner assisted me in obtaining a quantity of seeds, 700 in all. The pods when ripe burst and go to pieces, and so the seeds are showered on the ground. At daybreak next day we went in search of plants. We brought a strong iron hoe, as my intentions were to take up a good number, for I did not place much confidence in the seeds, although I am glad to state they have turned out well. Our course was directed to a more distant part than I had previously visited. Shortly after entering the bush-like forest we came on a large tract of land covered by immense masses of grey granite, some of which might be 50 tons or more in weight. These had been broken

where they lay, and were the result of a volcanic explosion. Rounded masses of the same rock also cropped out in many places. Travelling now became very difficult, as we had occasionally to scramble from one block to another on our hands and knees. Many good-sized rubber trees were growing in the spaces between those granite masses, but no plants were seen. The situation was very dry, but no doubt some seedlings had sprung up, which, owing to numerous thickets of shrubs, were not perceived. After fully an hour of tiresome exploring I resolved to go back to the place where I got plants previously. We there succeeded in collecting a number, which, with those formerly gathered, amounted in all to 60. The handle of the hoe broke, for which reason the work was not further prosecuted. Taking with me the seeds and plants, I returned to the steamer in the afternoon.

System practised in bleeding or tapping the trees, and collecting the Rubber.—This is an operation of a very simple description. On commencing to work the collector takes with him a stout knife, and a handful of twigs to serve as a broom. Arriving at a tree, any loose stones or dust are swept from the ground around the base, and some large leaves are laid down to receive the droppings of milk which trickle down. Some do not go to the trouble of sweeping the ground or laying down leaves, for which reason the milk adheres to sand, dust, decayed leaves, and other impurities. The outer surface of the bark of the trunk is pared or sliced off to a height of four or five feet. The milk then exudes, and runs down in many tortuous courses, some of it ultimately falling on the ground. After several days the juice becomes dry and solid, and is then pulled off in strings and rolled up in balls, or put into bags in loose masses. Only a thin paring should be taken off, just deep enough to reach the milk vessels; but this is not always attended to. Nearly every tree has been cut through the bark, and a slice taken off the wood. Decay then proceeds rapidly, and many of the trunks are hollow. In this condition the trees must yield far less milk, and many, no doubt, are broken over by the wind or wither away. Collecting is carried on during the dry season only when rain seldom falls.

Climate and Temperature.—The flat country from Ceara, running back to the mountains, in which the tree abounds manifestly possesses a very dry arid climate for a considerable part of the year. This is evident from the fact that mandioca and other crops require to be irrigated. The rainy season is said to begin in November and end in May or June. Torrents of rain are then reported to fall for several days in succession, after which the weather moderates for a brief space. According to some statements, there are occasional years in which hardly any rain falls. This assertion concurs with the aspect presented by the country in general. The daily temperature on board the ship ranged from 82° to 85° Fahrenheit, but inland it is often probably 90°.

The localities traversed by me nowhere seemed to be elevated more than 200 feet above the sea. The situations selected for cultivation in India should possess a rather dry and sustained high temperature. In the comparatively low-lying coast country of the southern portion of the peninsula of India, including the districts of Madras, Cochin, Calicut, Cannanore, Mangalore and Bombay will be found many localities possessing all the conditions essential for the growth of Ceara rubber. The plant might likewise be tried in the deep tropical valleys of Assam, and, indeed, in all the parched regions of India within the limits of coffee planting. It may not be safe, at least until some experience is gained, to plant in any locality where the temperature at any time of the year falls below 50° Fahrenheit.

Propagation and Planting.—Seeds are early produced if the tree is not shaded. They should be buried in brown sand, kept pretty moist until there are indications of growth, when they may be planted out permanently. In some situations where the ground is rough and strong they might be sown broadcast. Meantime I would suggest the formation of plantations by cuttings, which will take root as easily as a willow. These should be taken from the points of strong shoots, and may be one foot in length. In planting, each cutting may be put down in the soil to a depth of six inches. If scarce, the entire shoot may be cut into pieces, each possessing a bud, all

of which will grow if covered with half an inch or so of soil. On loose sandy soils or exhausted coffee land, plantations may be formed at little expense. Dry, hard, gravelly wastes, if found to support any kind of bush, are also suitable sites. Holes might be made in strong land with an iron jumper, and a stout cutting put into each and filled with pebbles. On bare or thinly-covered portions of rock the cuttings might be laid down flat, and a little heap of stones or any kind of *débris* about the size of a molehill, piled over each, care being taken that the extreme point of each cutting with a bud is left uncovered. I do not advocate planting in an entirely barren desert, but wherever there is any sort of stunted tree or scrub vegetation, with an occasional sprinkling from a monsoon shower, the tree is likely to prosper. Ceara rubber occupies a position in the market. The export has been stated to amount to 1,000 tons per annum.

Arrival in England.—The steamer left Ceara on 2nd October, and arrived at Liverpool on the 22nd of November. The plants were deposited at Kew early on the morning of the 23rd. There were fully 1,000 plants of Para rubber, *Hevea Braziliensis*, in the best condition. Exclusive were the Ceara plants, all of which arrived sound and have done well.

I have looked at the collections of dried plants in the State Herbarium at Kew, but no specimen could be found of the Ceara rubber tree. Judging from pieces of the capsules and the seeds, it would seem to belong to the same family as the Para sort. From the fact that it has tubers attached to the roots, Professor Oliver, the Curator of the Herbarium, suggested its similarity to the mandiocca (*Manihot*), and this in some respects is really the case. The tubers are probably poisonous, which, however, is a prominent feature of the *Euphorbiaceæ*, but in the form, markings, texture, and liability to rot when cut or bruised, they strikingly resemble some varieties of mandiocca.

Observations relating to the Rubber-producing Tree of Central America.—I will now add a few remarks concerning this tree, which I collected in the interior of the Isthmus of Panama towards the latter end of 1875. This, because I think it has

not received the attention it deserves. There are now a good collection of plants at Kew, and I am surprised that more have not been sent to India.

The tree inhabits wooded regions near Guayaquil and Buenaventura, and has likewise been met with abundantly in the State of Panama, and in the Republics of Costa Rica, Nicaragua, Honduras, Guatemala, and Mexico. It is one of the largest and most massive of the trees of western tropical America. The trunk often attains to a surprising thickness and height, yielding in some instances above a hundred pounds of India-rubber. The wood is extremely soft, and when cut into decays rapidly. The destructive method of cutting down the tree to be tapped has exhausted extensive rubber localities; and, although others may be opened up, yet the supply is certain to diminish at no distant date. Even where the trees are not felled, as in Nicaragua, the method of tapping, by which the wood is injured, is so unskilful that it has been considered by some as preferable to cut the tree down at once. The climate of various of those rubber districts is hostile and severe, and some places, such as the forest regions of Buenaventura and Choco, have no parallel in the universe. Throughout the State of Panama drenching rains are almost of daily occurrence, and occasionally on the Atlantic side hurricane blasts make avenues in the forest.

The district investigated by me, and where the plants were collected, was reached by ascending for some distance the River Chagres, and then travelling for several miles through a stately forest into the heart of the isthmus. The trees seen exceeded in height and dimensions those met with in the wooded districts of the Amazon. An undergrowth of a thorny wild pine apple (*Bromelia*), 10 feet in height, everywhere formed extensive thickets. Large powerful snakes were numerous, and so audacious that they deliberately rose up to strike at any one that approached. The young rubber saplings were found growing most abundantly on the banks of cool, clear running streams and little dribbling rivulets. The roots could easily be traced over the surface of the ground running down to the very margin of the water. But the tree grew also on emi-

nences, steep declivities, and varied elevations, and in such abundance that the first explorers gave the name "Caoutchouc Hill" to a height which they found crowned with a forest almost entirely composed of rubber trees. It was not seen growing anywhere on swamp or marsh land. Although the rubber districts are proverbially rainy, yet the tree was seen by me growing beside a stream on the border of a desert tract of country bounding the Gulf of Guayaquil, where only a few light showers of rain fell during the year. On both sides of the stream there was a strip of good forest, but beyond thickets of cacteæ and low spreading legumes formed the characteristic vegetation. I mention this fact to show that the tree will probably succeed well in regularly-irrigated districts, even if the atmosphere be dry and dusty. The temperature in the woods of the isthmus ranged from 75° to 88° Fahrenheit. Rain water, examined the moment it fell, was never found to be below 74°. The usual practice in collecting the milk was by felling the tree, and then making deep notches around the trunk at distances not exceeding one foot apart. Broad leaves were placed beneath these to receive the milk, which afterwards was collected in a large calabash or other vessel. A hole was then dug in the ground, and the milk poured into it and thatched over with leaves. It coagulated in about two weeks. Another method was to bruise a handful of the large broad heart-shaped leaves of a climber, a species of *ipomea*, and stir these about in the milk. By this operation the milk thickened in less than an hour, having the appearance of a jelly-like mass, but very porous, and exuding profusely a black ink-like water whenever touched or moved. This system of preparation produces an inferior article, and I have seen some buyers from the United States cut up the large juicy flakes into slices, an inch or so in thickness, and dry them in the sun. The temperature of the sea-water along the west coast, where the rubber tree grows, is high, and does not vary much during the year. In the Gulf of Guayaquil it is usually 78°, at Buenaventura 80°, and in the Bay of Panama 79°. The water of the River Chagres, although 80° in fine weather, falls during violent rains to 76°. On such occasions many fish are to be

seen in certain places floating about in the water benumbed-like or dying. I do not know if this is the result of the sudden lowering of the temperature, or if it is to be attributed to the great quantity of decayed vegetable matter brought down by the discoloured swollen torrents from the interior of the forests.

In India there are many districts which possess all the climatic conditions necessary for the successful cultivation of Central American rubber. From Bombay southward the majority of the deep debouches of the ghauts coming from the base of the western slope of the Malabar hills, including the humid forest region extending in places down towards the coast, contain many excellent sites. In Ceylon and Southern Burma and the Malay Peninsula, the tree is likely to thrive in all proper situations. Calicut is about in the same latitude as the centre of the region occupied by this rubber tree in its wild state. The deep recesses of the Sispara Ghaut really closely resemble some of the caoutchouc districts adjoining the River Dagua. The sites selected ought to be at low elevations, and no place should be tried where the temperature at any time during the year falls below 60° Fahrenheit. Marsh land must be avoided. In dry desert localities the tree may be expected to do well when planted along the banks of canals, or any description of channels where water is flowing for the whole or a portion of the day. Trees in good situations will produce seeds early, but these will require to be planted without delay, as drying destroys their vitality. But cuttings must be resorted to first, and stout branches, cut into pieces each possessing a bud, and covered lightly with soil, will generally be found to grow. Strong cuttings, a foot in length and furnished with buds, when planted in the usual way, will become strong plants sooner. However, the propagation of this tree will not be found so easy as the Ceara rubber.

In the planting out of young plants, the petiole or leaf stalk of the lowest or oldest leaf should be buried in the soil. By following this simple rule the plant commences to grow at once, its growth is vigorous and the trunk symmetrical.

But if at the period of planting there is much bare stem above ground, then growth is usually slow, the plant remains "leggy" for some time afterwards, and never makes a good tree. If the plants get a little attention until they are four or five feet in height, I do not think there is any description of weeds or forest growth in India that will afterwards overtop them. The rapid growth of this tree, by which a large amount of vegetable mould is added to the soil, is an important feature. My own opinion is, that if planted in suitable places and properly wrought, it will be found to yield a larger return per acre than any other plant or tree cultivated in India.

Concluding remarks.—In commencing the cultivation of these trees in India, it may be well to ascertain by actual experiment, as early as possible, the species likely to yield the largest amount of caoutchouc. It is possible that as regards quality there may be little, if any, difference in the milk of the various kinds when collected and prepared in the same way.

As has been already stated, each of the three sorts require rather different sites, a wet or swamp situation being most natural to the Para tree, while the moist banks of rippling streams or rivulets will be found well suited for the species from Panama. The Ceara tree is not delicate, and will grow and produce rubber in situations where oth er kinds if planted would be dried up. For these reasons, it is likely to prove a valuable plant in India in parched-up regions and stony unproductive lands thinly covered with soil. The cup method, if employed in an extended way, may be found a convenient mode of tapping. Thus 20 rows of cups distributed over the entire trunk might be put on at one time. The earth could also be cleared away from underneath the large roots to allow of their being properly tapped. Even by the rude method adopted in South America, by which the wood is much hacked, the roots are found to yield milk abundantly at all seasons of excellent quality. But whatever method is adopted, it is evident that if care is exercised tapping may be carried on continually. The Para tree in many localities gets no rest, except during a very "wet moon," or when the collectors are

drinking *cachass*. Therefore, the idea of giving the trees one or two years' rest ought not to be entertained. The Ceara method of paring off the surface of the bark might be tried on any of the sorts in dry weather. Para and Panama trees may be tapped on attaining a diameter of say 6 or 8 inches, and that of Ceara with a diameter of 4 to 5 inches. A collector in a plantation working with cups should be able to collect easily from 8 to 10 pounds of rubber per day. On the Amazon, in newly-opened districts, where the trees have not been operated on before, practised hands are sometimes able to collect from 20 to 30 pounds daily. A much greater quantity may be collected in even a shorter time on the Isthmus of Panama and adjacent regions, but then the trees are cut down to obtain the milk—a plan which it is assumed will not be followed in India. The cup process of tapping, the most general in use in the Amazon valley, is an Indian method, and is said to have been in use amongst them at the time America was discovered.

No time should be lost in reducing the milk, when collected, to a solid state, for if this matter is delayed, decomposition takes place, which furnishes much of the impurity complained of by manufacturers. If possible, the milk should be coagulated on the day it is collected. The milk of some species, such as that of the Panama rubber tree, may keep for a week or more in a cool shady place, but Para rubber milk spoils within the space of twenty hours, and gives off a most disagreeable odour. All the Para rubber is prepared by the smoking method I have described. Where nuts cannot be easily found green foliage is used instead. The "fumes of sulphur," "ammonia," or "acetic acid" are never employed. Alum is generally used in thickening the "mangaba" milk in the south of Brazil, but it appears to destroy the elasticity of the rubber. The watery portion may be evaporated by placing the milk, in small quantities at a time, in shallow vessels attached to any simple form of hot-water apparatus. Either this or the adoption of a smoking method similar to that of Para will probably be found the best. The material should be prepared in thin flakes about 1½ inches in thickness.

Those pieces, if made square in the form of a bale, could be fastened together and covered with coarse cloth. In this way rubber would be both easily handled and stowed.

The milk of *Masseranduba* (*Lucuma procera*), and of one or two milk-yielding trees of the Amazon districts reported to be mixed frequently with Para rubber, possesses no elasticity when prepared separately.

The island of Borneo has been suggested to me as a place specially suited for the formation of India-rubber plantations. No doubt they would grow there as well as in India, but probably not any better. Although the position in point of latitude may appear in favour of Borneo as regards the Para tree, I doubt if the climatic conditions of that island excel in any particular the southern portion of the Madras Presidency at low elevations. It must be remembered that what is termed by some the "equator of heat" is considerably to the north of our geographical equator. On the American continent it may, I think, be placed at not less than ten degrees of north latitude. In the dense forest regions of the Amazon and Panama Isthmus, the most striking feature is the extraordinary development of certain trees, occupying large spaces of ground, chiefly *ficus* and *bombax*, mantled by a dense profusion of leafy climbers, the trunks and branches clothed with parasitical plants. In India, as for instance, in the best forest portions of the Sispara Ghaut, there are no conspicuous large trees with buttressed roots, but there is a far more even development of general forest trees, and I have no doubt if an acre of such land was cleared, and the wood thereof weighed, it would be found to equal, if not exceed, the product of a similar extent of ground in the wooded districts of tropical America. Apart, however, there remains a more positive proof of the capabilities possessed by the climate of Southern India. The cocoanut and mango trees can only be cultivated in the hottest regions of the tropics. Now I have visited places where these trees were planted by the natives, such as Jamaica, Hayti, St. Domingo, Porto Rico, Santa Martha, Carthagena, Panama,

Buenaventura, Jumaco, Bahia, Esmeraldas, Guayaquil, and Para, but nowhere was the fruit superior, nor hardly so large as the mangoes or the cocoanuts of the Malabar coast. For these and other reasons I have confidence that there exist the necessary conditions for the successful cultivation of the American rubber yielding trees in many parts of India.

In conclusion, I trust the way in which I have performed these services may be considered satisfactory.

I am, SIR,

Your most obedient Servant,

ROBERT CROSS.

Ficus elastica in Arakan.

No. 19.

To the Commissioner of Arakan.

Dated Arakan Hill Tracts, May 23rd, 1878.

Sir,—Referring to your Docket marginally noted, received only on the 15th instant, I have the honor to report, for the information of Government, that the rubber which has this dry season been brought down for the first time to our Northern Frontier by Clans of the little known "Shandoo" or "Poor" race is alleged by them to be received in barter from the "Looshais;" but as these Shandoo Clans are of the wildest and most suspicious character, it has been undesirable to press them too closely on the point of the locality from which they obtain the same, as several had never before seen a European, neither visited us.

No. 411 of the 24th ultimo.

2. If too much eagerness is evinced on the subject, on first introduction to our new guests, they will leave with the impression that, if we learn the source of the product, Government may occupy their country, and hence the information, meagre as it is, elicited from them on the point, in course of casual conversation (for direct queries are out of the question), has to be received "quantum valeat."

3. The Tribes who have recently brought down the trade mostly reside to the south and north of the "Blue Mountain,"* and some in territory, a large portion of which is unsurveyed and undefined.

For position, *vide* O'Donel's map, published by Government of Akyab District.

4. My own impression is that the *Ficus elastica* is indigenous to the above tract of country, and that the theory of their obtaining the same from the Looshais is a blind, because—

1*st*.—The natural outlet of the rubber trade from the Looshai country is "Demigiri," in the Chittagong Hill Tracts;

2*nd*.—The relationship of the above referred to "Shandoo" tribes with the "Looshais" is the reverse generally of that intimate and friendly kind which would allow of their obtaining it, when the Looshais have had for some years a good mart for it in the Chittagong Hill Tracts.

3*rd*.—Indirect information supplied me points to the fact that the *Ficus elastica* is to a limited extent indigenous to the tract of country about half a degree south of the Blue Mountain.

5. *I trust next season to have time to learn more of*, and improve our relationship with, these independent tribes, who mostly bring this article down, and heretofore only known to the Government as inveterate marauders on British Territory. I shall then be in a position to afford more definite information on the subject. Doubtless if the Arakan Hills is the *natural outlet*, and not the adjoining frontier of Chittagong, as also if our border remains *quiet*, a trade in this new industry will be established. It may be observed here, as pertinent to the question, that when on duty at Chittagong in September last I ascertained that for the last two years there had been a marked decrease in the amount of rubber exported from the Hill Tracts. An explanation on this point is deserving of attention.

From Deputy Commissioner, Chittagong Hill Tracts.

I have, &c.,
W. G. HUGHES, *Captain*,
Supdt. of A. Hill Tracts.

* The "Blue Mountain" is in latitude 22° 30," N.

Introduction of Rubber Plants into India.

From Her Majesty's Secretary of State for India, to the Government of India,—No. 18, *dated the 9th May* 1878.

On receipt of Your Excellency's letter No. 11 of the 22nd February last, relative to the distribution in India of the plants of the Copaiba Balsam, and of the Hevea, Ceara, and Castilloa rubber plants, a copy of it was forwarded to Sir Joseph Hooker, with a request that the wishes of your Government in this respect might be attended to.

2. I now transmit, for your information, copy of the reply* received from Sir Joseph Hooker, which contains a review of the operations undertaken at the Royal Gardens, Kew, in effecting the introduction of India-rubber plants into India.

* Dated 17th April 1878.

From—W. T. Thiselton Dyer, Esq., *Assistant Director, Royal Gardens, Kew, to the Under Secretary of State for India,—Dated 17th April* 1878.

I am desired by Sir Joseph Hooker to acknowledge the receipt of your letter of the 6th April, transmitting an extract from a letter from the Government of India, and requesting the transmission to Ceylon of certain stocks of Heveas and Castilloas.

In replying to this letter, Sir Joseph Hooker thinks it will be convenient that I should review the whole operations of this establishment in effecting the introduction of India-rubber plants into India.

1. *Hevea braziliensis* (Para rubber).—On 4th June 1873, we received from Mr. Markham some hundreds of seeds obtained from Mr. James Collins. Of these seeds less than a dozen germinated, and six of the plants so obtained were taken out by Dr. King, Superintendent of the Botanical Gardens, Calcutta, in the same year to India.

The climate of Calcutta did not prove very favorable to the Heveas, which require the conditions of growth met with in hot and moist tropical forests. It was, therefore, decided in

consultation with Mr. Markham that, in the event of more Heveas being raised and sent out from Kew, they should be received at the Botanical Gardens in Ceylon, which should then be regarded as the depôt for supplying young plants to such parts of India as were found to be suitable for its growth.

On June 14th, 1876, we received from Mr. Wickham about 70,000 seeds, of which about 4 per cent. germinated.

On August 9th we despatched 1,919 plants raised from these seeds to Ceylon in 38 Wardian cases, in charge of a gardener. Of the whole consignment 90 per cent. reached Dr. Thwaites in excellent condition. All subsequent accounts have been satisfactory, and no difficulty is found in multiplying the plants by propagation to any extent.

On August 11th, 50 plants were sent to the Botanical Garden at Singapore. Owing to the delay in the payment of the freight these plants all perished.

On August 23rd, 50 plants were sent direct to Major Seaton in Burma. These reached their destination in bad condition.

On September 29th a further supply of 100 plants was taken out to Dr. Thwaites, in charge of Mr. Duthie, Superintendent of the Botanical Garden, Saharunpur. These reached Ceylon in good order.

On June 11th, 1877, 22 plants were sent to the Botanical Garden, Singapore. The Superintendent reports that the climate appears suited to their growth.

On September 7th, 37 plants were sent to the Botanical Gardens in Mauritius, and reached their destination in good order.

On September 15th, 100 plants were again sent to Dr. Thwaites, and 50 to Calcutta, in charge of Mr. Morris, Dr. Thwaites's Assistant. Both consignment reached their destinations safely. Of those sent to Calcutta a portion was immediately despatched by Dr. King to Major Seaton, with whom they are now doing well.

It appears, therefore, that while upwards of 2,000 plants are safely established in Ceylon, smaller parcels are also growing in Burma, Calcutta, Mauritius, and Singapore. The plant is

now therefore to be regarded as definitely established in the East Indies, and with ordinary horticultural skill there should be no difficulty, in the course of a few years, in raising an indefinite number of young plants.

Beyond keeping a small stock for occasional distribution, it does not appear that this establishment is called upon to take any further steps for the propagation and distribution of this plant to India.

I should add that, on November 21st, 1876, Mr. Cross reached Kew with about 1,000 young plants brought direct from South America. Only about 3 per cent. of these plants survived, and they therefore contributed but little to our resources for distribution.

2. *Castilloa elastica* (Rubber of Central America.)—Sir Joseph Hooker has already stated, in a letter to the India Office, dated April 1st last, what has been done with respect to this kind. I quote the following passage :—

"The cuttings brought home by Mr. Cross were received on October 3rd, 1875. [The seeds (7,000) received previously failed to germinate.] Steps were immediately taken to establish and propagate them, and on August 9th, 1876, 32 healthy plants were forwarded to Dr. Thwaites, 28 of which he subsequently reported were well established in Ceylon and doing well.

"On September 15th, 1877, a further consignment of 24 plants was transmitted to Dr. Thwaites, in charge of Mr. Morris."

A few plants have also been sent to Mauritius and Singapore.

The propagation of this species will, for the present, be continued at Kew, and during the ensuing summer a further small consignment will be sent to Ceylon. Cuttings do not strike so readily as those of the Hevea, and the multiplication of plants is therefore necessarily slower.

3. *Manihot glaziovii* (Ceara rubber.)—Mr. Cross brought to Kew on November 21st, 1876, seeds and cuttings of this plant, from which a stock of 55 individuals was eventually obtained.

On June 11th of last year, four plants were sent to Singapore, and on September 15th, at which date our stock had increased to 300 plants of all sizes, 50 were sent to Dr. King at Calcutta, and 50 to Dr. Thwaites in Ceylon, both in charge of Mr. Morris. All the stems collected by Mr. Cross were divided between these two recipients. At the end of the year our stock amounted to about 450 plants. There will be no difficulty, therefore, in sending a supply of plants of this species to the Conservator of Forests in Madras in accordance with the wish of the Government of India. It will, however, probably be most convenient to treat Calcutta as the depôt for the Ceara rubber plants, as Ceylon must be for Heveas and Castilloas.

With respect to plants of the Copaïba Balsam, nothing can be done. From the five seeds brought to Kew by Mr. Cross, *November 21st, 1876, only two plants have been raised*, and these grow with excessive slowness. Nothing can therefore be done at present in propagating them.

Recapitulating, I have therefore to state that Sir Joseph Hooker is of opinion—

1. That it is unnecessary to transmit any more Hevea plants to India, and that application should be made for them to Ceylon when required for experimental cultivation.
2. That as *the stock of Castilloas at Kew increases*, further consignments should continue for the present to be made to Ceylon.
3. That plants of the Ceara rubber may with advantage be forwarded to Madras, but that the principal stock of young plants should be sent to Calcutta, from which they can be distributed.
4. That for the present nothing can be done, as far as Kew is concerned, with the Balsam of Copaiba.

From the Government of India, to Her Majesty's Secretary of State for India,—No. 23, *dated the* 1*st July* 1878.

We have the honor to acknowledge the receipt of your Lordship's despatch No. 18, dated the 9th May last, forwarding

copy of a letter from the Assistant Director of the Royal Gardens at Kew, which contains a review of the operations undertaken at those gardens for introducing the American rubber trees into this country, and, in reply, to express our concurrence in the proposals made therein, *viz*:—

That no more plants of the *Hevea braziliensis* need at present be sent to India or Ceylon;

That plants of *Castilloa elastica* should continue to be sent to Ceylon; and that the Botanical Garden at Calcutta should be made the depôt for the plants of the *Ceara* caoutchouc.

2. We would beg your Lordship to convey our acknowledgments to Sir J. Hooker for the services rendered by him in connection with the rearing and despatch of these rubber plants to India.

3. With regard to the origin of the arrangements for the cultivation of the rubber tree in Ceylon, we have the honor to state that in July 1875, Dr. King, the Superintendent of the Botanical Garden, Calcutta, reported that the plants brought out by him from Kew in 1873, had not done well at the Garden, and that he feared the tree would not find a congenial home in any part of Northern India. He suggested that it would probably thrive in Ceylon; and it was accordingly arranged, in communication with the Government of Ceylon, to use the Botanical Gardens there as a depôt for supplying rubber plants to British Burma and other parts of India.

Timber Trade in Assam.

The principal sources of demand for timber in Assam are for the following purposes :—

Boat-building and dugouts, construction of houses and bridges, making charcoal, and for local use by the inhabitants, fire-wood, troughs for cattle, rice mills for husking rice, wooden seats, ploughs, and yokes for cattle, cart-wheels, and sugar-crushing mills.

The better class of furniture is almost all imported from Calcutta and Dacca, although excellent woods for this purpose are found in Assam.

Paddles for dugouts are largely made in Upper Assam of Bola wood, *Morus lævigata*.

Boat-building, as the largest industry, first claims our attention. The boats are built with smooth sides, not in clinker fashion, and are of burdens up to 1,000 maunds. They are largely employed in the carrying trade on the rivers in the province, and the demand for timber for their construction exceeds the supply, and is likely to enhance considerably the prices of the better classes of timber. The timber used in this industry is principally Sal, Sama (*Artocarpus chaplasha*), Jarul or Ajhar (*Largerstræmia regina*), and rarely Tittasappa (*Michelia champaca*) being also employed.

Other woods might certainly be used with advantage, but are not at present known in the trade. In Assam, Sal is almost confined to the districts of Goalpara, Kamrup, and the Garo Hills; the few blocks of Sal forest in Nowgong and Darrang being of inconsiderable area, and none at all existing in the districts further up the valley of the Brahmaputra.

From the earliest times on record the trade in Sal and Sama appears to have existed, nearly all the timber sold being brought down to sand churs at the mouths of the affluents of the Brahmaputra, at the end of the rainy season.

Hundreds of thousands of logs were annually sold at these timber markets, to merchants from Lower Bengal; and boats manned by Bengalis, and by Marawabadis who speak Hindi, and bring down from the Ganges boats built clinker shape of Badri timber, are used to float the logs to their destination at rates from Re. 1-8 to Rs. 2-8 per pair of logs according to the demand.

Latterly, wholesale destruction of timber by cotton jhuming and felling immature trees has so ruined the forests that the supply of timber suitable for boat-building is yearly becoming scarcer, and the quality fast deteriorating.

For cotton jhuming Sal forest is preferred, as young Sal trees are easily felled, and there is little or no undergrowth to clear away. I visited last year a cotton jhume in a zemindari forest, near Dhubri, and think that a description of it might not be inopportune.

An area of four or five acres of dense young Sal forest had been cleared, every tree being felled; and the stems were cut into lengths, and used as palisades, six feet above the ground all round the jhume.

The branches had been burned before the cotton was sown. Sleeping changs, raised 10 or 12 feet above the ground, were the only habitations.

At the entrances to the jhume pit-falls of 6 feet in length and depth and 4 feet broad had been dug to catch wild buffaloes, or rhinoceros, or other intruders from the surrounding jungle.

The cotton was full of pea fowl, and I shot three whilst walking round near the palisades, as they flew over into the Sal forest outside.

On such jhumes only one crop of cotton is raised, so that the rate of destruction of the forests may be readily imagined.

The log used for boat-building is called the *Dham*, and should exceed 4½ feet in girth, and in length between 6 and 7 feet, and be entirely of heartwood.

At present the *Dhams* are of girths down to 2½ feet, and are merely rounded, still containing sapwood, and the wood is so bad that boats which, if built of heartwood, would last without repairs for twenty years, now require constant patching, and can be scarcely kept together for more than five or six years.

Sama dhums are scarce, and of larger dimensions than Sal. The wood is therefore better esteemed, and fetches rather higher rates, chiefly on account of the absence of sapwood, which in Sama is so bad as not to pass muster at any market.

Tittasappa is of equal rank with Sama, but even rarer.

Jarul dhums, though of large girth, frequently up to 8 feet, and without sapwood, are liable to split when exposed to the sun, when stacked for sale on the sand churs.

The rates obtained for Jarul are, therefore, less than for the other woods; although it is of excellent quality for boats, if not split, and for all work in-doors.

The logs are worked out in the cold season by Mechi wood-cutters, called banatis, under a Duffadar.

The latter advances money for food and implements, and pays royalty and other charges on the timber. After the sale, he takes half the price obtained, and pays the other half to his men. The royalties charged have been out of all proportion to the price obtained by the Duffadars, until quite recently, and many of these men have made considerable sums of money, though they still retain their simple habits, and mostly bury their cash in earthen pots.

One of them is said to have lent a sum of Rs. 30,000 to the Parbotjuar zemindar.

Previously to 1870, only Rs. 4-4 per axe was charged in the Government Forests, which has been calculated at less than 2 annas 8 pies per tree, at a time when Dhums were selling at Rs. 10 to 15 a pair.

The Government rate is now Rs. 10 a Sal tree, and Rs. 6 for other trees, except in the Garo Hills, where Re. 1 per log was charged for Sal and Sama in 1876-77, although as much as Rs. 19 a pair was obtained for the Dhums, by the Duffadars, as some fine Sal timber still exists in the Garo Hills.

In the zemindary forests of the Goalpara district, royalties of Rs. 13-4 to 40 per hundred logs are charged according to their dimensions, and a further sum of Rs. 6-4 per cent. of value of sales effected is paid by the Duffadar to the land-owner.

The royalty paid to the Butirs is still only Rs. 4 per axe, and Rs. 7 for each gang of wood-cutters, called a Bada.

But timber cutting is exposed to other perils besides attacks of tigers, and sudden risings of the mountain streams in Bhutan; and, owing to the constant fighting going on amongst the people, no banatis have gone up to the hills during the present year.

Besides the royalty on timber cut in their zemindaries, the owners of the sand churs, on which it is stacked for sale, charge a rent called tolljhat, now levied at 4 annas a log for every log stacked, whether cut in their own estates or elsewhere.

This right of charging tolljhat gave rise to considerable trouble; when it was wished to take up land for Government depôts at the different timber markets, the zemindars claimed *compensation, amounting to 6 lacs of rupees, for three such* plots of land. It has, however, been found possible to acquire the land without paying such extortionate demands.

The prices now realised for dhums of Sal, Sama, or Titta-sappa range from Rs. 5 to 20 a pair, and for those of Jarul from Rs. 5 to 6.

The dhums are always cut at the base of the tree and contain the best of the timber. Next in importance are the house-posts, of which the Gul is the best.

As in the private forest, scarcely any trees of sufficient girth, for even the wretched dhums of the present day, can be found; the house-posts are taking their place in the market.

They are all of Sal timber, and are classed as follows, the prices given being the average obtained in 1876 :—

Name of Log.	*Length.*	*Prices per 100 Logs.*
Gunis	10½ feet to 12 feet.	... Rs. 40.
Derhatis	12 „ to 14 „	... not known.
Guls	16½ „ to 19 „	... Rs. 275.
Dootis	19 „ to 21 „	... „ 150.
Gadams	24 „ to 30 „	... „ 300.
Bishatis	30 „ and over	... „ 325.

The *dhams* which appear last in the list are young trees with little or no heartwood, and are fastened transversely across the boats used for floating down the timber, which is suspended from them by jute ropes.

The various classes of house-posts are *eagerly bought up for* house-building in Lower Bengal; none of them exceed 3 feet in girth at centre, all timber over such a girth being cut into *dhams*.

The only large logs now removed from the forests are those worked out by the Forest Department, which are mostly sold for public purposes.

Owing to the scarcity of labor in Assam, and to the convenience of getting timber ready sawn up, teak scantling, costing Rs. 2–8 per cubic foot landed at Dhubri, and at proportion

ately higher rates at stations further up stream, has been lately imported for local purposes, although Sal has been available in the rough at Re. 1-8 and at 1-4 per cubic foot, and is a better building wood than Teak.

The demand for dugouts is also very large, and boats of Sal, Sama, or Tittasappa, measuring 6 to 8 hands across the back, sell for Rs. 120 to 200 each. Such trees are getting rarer, and more inaccessible every year, and dugouts are now made out of softer woods, such as Gugera or Chelani, (*Schima mollis,*) and others, which only last a few years.

A statement prepared by Mr. Mann gives statistics of the consumption of tea boxes in Assam in 1875.

Leaving out Sylhet and Cachar which this article has not considered in treating of the timber trade of Assam Proper, or as it is now called the Assam Valley Districts, we find that 137,102 tea boxes were exported from Assam, and 135,718 imported; thus not more than 2,000 appear to have been made in the province.

Each box contains about a cubic foot o timber.

Most of the boxes come from Burma, and cost Re. 1-5 each in Calcutta.

Considering the large forests of soft wood trees in all parts of Assam, it is only the scarcity of the population which can account for such an import of wood into the province. In the Goalpara district there is a small population of Mechis who have been wood-cutters for generations; these men are already engaged in timber works in Government Forests, so that it is hoped that the anomaly of importing Burmese timber into al argely-wooded country will not continue long.

The quantity of charcoal used annually can be readily calculated from the quantity of tea exported, the exports in 1875 being about 12,340,000 lbs. The Government charge is for the right of making charcoal 2 annas a maund, but most of it is manufactured in private forests.

As to the articles for local use there are no statistics available; rough pieces of Bola wood for making paddles are sold for 8 annas to 12 annas each in the markets in Assam, and ploughs,

yokes, seats, rice mills, and rollers of Sal or Ahoy (*Vitex altissima*) are sold at the markets on the Dhubri and Kuch Behar road, at prices from 6 to 8 annas each. The people help themselves freely from the zemindary forests, and only expect to be compensated for the labour of cutting and bringing their goods to the market.

To facilitate their search for houseposts, fire wood, and wood for implements, they have been accustomed to fire the forests at the end of every cold season. As these practices are not allowed any longer in Government Forests, the cultivators talk of emigrating southwards from near the Forests in the Duars to the zemindary lands.

From the above remarks, it can be readily imagined that the Private Forests, though extending over several hundred square miles, will soon yield nothing at all.

Those in the Garo Hills, where there is no check to jhuming, seem to be destined to a similar fate in no short interval of time.

The imports of Burmese timber are not likely to increase, and have their origin more in the saving of labor than in the actual saving of expense.

Butir timber is very inaccessible, and the writer has reason to believe that Sal Forests in the Hills are not very extensive.

Government will soon be sole holder of all timber-yielding tracts in the Province, and the establishment of a general depôt at Dhubri, and the certainty of a supply there of all kinds of marketable timber will soon establish there the largest timber market in Eastern Bengal, and the introduction of steam machinery for sawing up scantling and tea boxes is mere matter of time.

W. R. F.

A Manual of Indian Sylviculture.

Sir,—As a foundation for all correct work in dealing with our forests, it is necessary that every Forest Officer should possess the latest and most certain information in relation to every tree with which he is brought into contact in his professional capacity. This is a truism; but how unsettled, how unsatisfactory is often the knowledge of even Divisional Officers on the subject of the most important among the trees constituting the forests under their care, and hence what faults in treatment, what a waste of time and of money through carrying out operations which the experience of others have already condemned! How often does it not happen that an officer is transferred to a province or to a part of the same province with the forest vegetation of which he is quite unacquainted, and the requirements of and specialities inherent in the various species composing which he can only learn

by long and patient observation, more especially in the case of an untrained Forest Officer whose mind is not drilled, and whose efforts are not directed by a perfect knowledge of the laws of forest growth.

Every year the department is recruited by a number of young men who are placed at a similar disadvantage. Many important operations are executed in our forests by men who, for the above reasons, are not competent to do them, and the forests, of course, suffer in consequence.

It is, therefor e, imperative that we should have some standard guide to the cultural requirements of all our most important forest trees. Such a work would not obviate all necessity to learn for ourselves. But it would direct us in the right way and considerably shorten our period of incapacity.

It is true that our knowledge on the subject is very imperfect as yet, but in order to develop the information we do possess, it is necessary that we should know the present range of such information, however small. As we gain in experience we must build upon this structure. Without a foundation we cannot construct at all.

Dr. Brandis's Flora is a most valuable work, and very useful are the other Floras at our disposal; but, as a matter of course, such works do not aim at giving the very detailed information here required, the specialities from a cultural point of view attaching to the tree. The soils, climate, exposition, slope affected by it, its growth, longevity, usefulness as a timber or for other purposes, its enemies, method of propagation either naturally or artificially, &c., &c.

All this mass of detailed information, which is quite necessary to render the Forest Officer really efficient, exists in the shape of accurate data in the heads of the many only, and not in that of any one person, even in the case of one kind of tree. The facts are scattered here and there. The experience of one officer needs the confirmation of others. The tares have also to be eliminated from the wheat. A mass of evidence requires to be carefully sifted and then condensed.

We have, it cannot be doubted, a number of officers among

us who take a very great interest in their profession; and indeed Forestry is in itself so attractive a science, that we can assume that most of us are continually observing the phenomena attaching to the growth of the different species of trees and the results of natural or artificial changes in the mass of a forest. Many of us have exceptional experience in the artificial re-production of some species, &c., &c.

The Forest Department has now been working for many years, and a valuable fund of information of all kinds must therefore exist. It is true that it is much diffused, the knowlege is unequally distributed, being in the case of every one officer more or less indefinite and lacking a more general confirmation.

It is my proposition that this information, imperfect as it may be, be made use of to form a foundation for the more noble edifice which will necessarily follow upon a more extended experience in the future. Without such a foundation in the shape of a Manual of Sylviculture in the hands of every officer, any addition to our knowledge in the future must be very slow and often questionable, and hence a really sterling work on the subject almost impossible. We have not to deal here with a country like France or Germany with a dozen species of forest trees, pretty equally distributed over the whole country, but with a huge continent, where both climate and vegetation differ widely, rendering it possible for one man to gather a complete knowledge of but a small number of its forest trees during a lifetime.

It stands to reason that such a Manual could never be compiled from contributions invited for the purpose to the *Indian Forester*. In the first place, it would take an endless time; and in the second place, many observing officers would be too bashful to bring their ideas before the public, some from a want of confidence in their theories, others from a lack of faith in their grammar.

I would therefore suggest, in order to effect the purpose desired, that every Forest Officer who has, by a residence of two years or more in one district, familiarised himself with the forest vegetation of those parts, be bound to furnish his

Conservator, upon being called to do so, with a memo. containing his ideas on the subjects required of him.

All memos. on the same subject would then be separately filed by the Conservator and sent on to some officer who, from his experience in India and his possession of other attributes necessary for the purpose, would be the fittest person to compare the intelligence before him, to sift it, to bring out in a compressed form all the useful information and matters of interest, and to add to the summary of each subject such data of a general nature as could not be expected from the contributors themselves, and thus gradually would the work be built up.

Forms might be served out containing the headings under which information would be required. This would prevent the discussion of superfluous matters on the part of the contributors and keep them from useless digressions.

Not least of the advantages of the plan here proposed would be a true insight into the real worth of the different Forest Officers, and a strong inducement to the indifferent to look about them more.

Yours faithfully,

FAGOT DE SAPIN.

1*st July* 1878.

The Catalpa and its Uses.

(*From the "American Agriculturist."*)

The Catalpa (*C. bignonioides*) is likely to receive much more attention at the hands of tree planters than heretofore. It is essentially a southern and south-western species, finding its northern limit in Southern Illinois and Indiana, but cultivated much farther northward. In exposed situations in northern localities, the tree is not seen at its best; the head is often very irregular from injury in severe winters, or the breaking of the branches by violent storms, and when naked is anything but an elegant object. When the abundant leaves appear, these defor-

mities are hidden, and the whole aspect is changed. The long petioled leaves, either opposite, or three in a whorl, are large, heart-shaped, downy on the under side, and of a peculiar shade of green. The flowers appear in June and July in large open panicles, often a foot long, and are produced in such profusion that a specimen in full bloom is a most pleasing sight. The individual flowers are about an inch long, elongated bell-shaped, with a wavy 5-lobed border, and somewhat two-lipped; they are white, and generally tinged with violet, and spotted within with yellow and purple dots. The flower are succeeded by long, slender, cylindrical pods, often a foot or more long, which hang until spring, and are so conspicuous, especially after the leaves have fallen, that in some localities the tree is known as the "Indian Bean." The pod is divided lengthwise by a partition, forming two cells, which contain numerous very flat seeds, having on each side a wing, which is much cut, and appears like a fringe. Boys often amuse themselves with the pods as substitutes for cigars, the cottony wings to the seeds giving an abundant, and probably innocent, smoke. As an ornamental tree, the Catalpa, with many merits, has some faults. As already mentioned, its naked branches are unsightly, and the leaves are among the latest to appear, while they drop with the very first frosts. Its bark, when wounded or cut in the spring, is said to emit a very offensive odour. The honey collected from its flowers is said to be poisonous, though we have seen no direct evidence upon this point. The name, *Catalpa*, is supposed to be derived from the Indians; it was originally described by Walter as *C. bignonioides*, from the resemblance of its flowers to those of the *Bignonia* or Trumpet-creepers; later botanists have called it *C. cordifolia* and *C. syringæfolia*; but these, according to the rules, should give place to the older name. It belongs to the Bignonia Family. Our principal reason for briefly describing the Catalpa, is on account of its economic importance. In most works on trees, its timber is briefly mentioned as "lasting," though Mr. Arthur Bryant in his work gives more importance to this quality, stating that he is assured that posts "have stood for forty years without the appearance of decay," and

advises its cultivation "to a limited extent." Probably the earliest advocate of the Catalpa was General Harrison (afterwards President), who, in an agricultural address at Carthage, O., in 1825, advised farmers to cultivate it on account of its great durability for posts, &c. He, when Governor of what *was then* the North-West Territory, found Catalpa pickets in the old French stockade at Vincennes, which were yet sound, though they must have been in place for a century or more. Later, Dr. Warder and others have given testimony as to its value. Mr. E. E. Barney, of Dayton, Ohio, has, as mentioned last month, done excellent service in collecting the scattered testimony as to the value of the timber of the Catalpa, adding to it important notes of his own, and presenting the whole in a pamphlet. Mr. Barney calls attention to the fact, first pointed out by Doctor Haines, of Dayton, that there are two varieties of the Catalpa; one blooms two weeks earlier than the other, has larger flowers, which are nearly pure white, with larger, longer, and fewer seed pods. Mr. Suel Foster, a well-known horticulturist of Muscatine, Iowa, has also noticed this difference, and found the early-flowering form to endure a winter which killed the ordinary kind. He proposes to call this form "*the hardy*," and the later blooming "*the common*" Catalpa. Those who contemplate tree-planting will do well to procure the pamphlet referred to (which Mr. Barney generously supplies for two 3c. stamps), as we can here only briefly sum up the evidence there presented. The valuable qualities of the tree are: ease of propagation; adaptability to various soils; rapid growth; freedom, so far as known, from the attacks of insects, and the great value of its timber, especially as to durability when exposed to the weather, or in contact with the earth. As to climate, Mr. Foster thinks that the common kind cannot be depended upon north of St. Louis, while the variety just mentioned has endured the severest winters of Iowa and Illinois without the least injury. That a variety in the color of the flowers, leaves, or fruit of a plant is often accompanied by a difference in hardiness, and that some varieties are more hardy than the type, is well known to cultivators, and is by

no means peculiar to the Catalpa. The seeds are sown in spring in nursery rows, thinned to about a foot, and transplanted when one or two years old, as may be most convenient. In the plantation they are set four feet apart each way; close planting is necessary to insure a straight, clean trunk. In twelve years, each alternate row may be cut out for telegraph poles or fence-posts, and in about twelve years more the remaining trees, in good soil, will make six railroad ties each. Mr. Barney estimates that at the present prices, a plantation of Catalpa will make a return of $25 per acre for each year of the whole time that the trees occupy the ground. Those who have only seen isolated and scraggy specimens can have little idea of the Catalpa as a forest tree; in favourable localities it has reached a diameter of three and even four feet, with a clean trunk of 50 feet, without a branch. The trunk of this tree is preferred in the South-west for making dug-out canoes, as they neither crack nor decay. The great durability of the timber seems to be well established, and several instances are cited in which posts set in the ground, or logs laying upon it, have been exposed from 70 to 100 years without perceptible decay. The great demand for the timber will be for railroad ties; for this use it should resist the crushing effect of great weight, as well as decay, and should also be able to hold the spikes firmly; so far as tried, the Catalpa ties have proved, when tested side by side with ties of oak, perfectly satisfactory in these respects. One great advantage of the Catalpa over most other woods is the inappreciable amount of sap-wood, or "sap," as the immature, recently-formed outer layers of wood are popularly called. This, even in cedar and other trees, the heart-wood of which is durable, decays rapidly, but even small stakes of the Catalpa suffer no appreciable loss from this cause. Besides durability, Catalpa-wood possess beauty to a remarkable degree; its general color is a warm buff, the "silver grain" being straw colored; it takes a fine polish, and is well suited to interior finishing and cabinet work. Mr. Barney, who is known at the West as "the Veteran Car-Builder," sends us specimens of the wood, cut in different directions, with one

surface polished; one of these is from the lower end of a bar-post that is known to have been in the ground for seventy-five years; and, though stained a little darker, is quite as sound as the others from trees cut last year. All present a beautiful polish.

JJJ. Notes and Queries.

Preparation of Bamboo fibre for Paper-Making.

TO THE EDITOR OF THE "INDIAN FORESTER."

Dear Sir,—I was somewhat astonished to see in your last issue a letter from Mr. Routledge, the well known pioneer of Bamboo Paper, criticising a report of mine on the preparation of Bamboo Fibre, which was printed in your issue of July 1877. I was as much astonished as I should be if a man told me he had used a steam hammer to crush a fly. Mr. Routledge has evidently over-estimated the importance of the Moharli experiment, and misunderstood its object, which I will now, with your permission, proceed to explain to him.

We had all of us heard and read a good deal about the suitability of Bamboo Fibre for the manufacture of paper; we at once recognised the superiority of this scheme over that other one of mingling the cast-off rags of ill-clad natives with old and equally useless cutcherry records. We were assured that we could prepare the fibre with comparative ease out in the jungles, and that the chief point was to choose the young shoots at the proper time, neither too young, nor too old. So we determined to prepare some Bamboo Fibre. We limited ourselves to this, for with our accustomed modesty we came to the conclusion that we scarcely knew enough about it to turn out actual paper. Starting then with the sole object of extracting fibre from Bamboos, three courses were open to us; we could have set a lot of men to beat out the young stems with sticks: this is a method used in jails for aloe and other fibres, and is excellent in results, if slow in procedure. This method would have taken too long, so we had to give it up; or we could have adopted the plan used by the Brinjaras of Central India in the preparation of fibre from the root of *Butea frondosa*; they chew it in their mouths, and the result is a beautiful fibre and pearly white teeth. The population of the

Moharli forest was not at that time sufficiently dense, nor were their teeth sufficiently good to warrant our adopting this method, and it had to be given up with reluctance. The third course was the one we eventually took. It is a great country for sugar cultivation, and at certain times of the year sugar-mills are at a discount. We had previously noticed the resemblance between the crushed stems of the sugarcane and the specimens of rolled Bamboo sent by Mr. Routledge for our guidance. So we set up our sugar mill, and went to work in the most approved method of sugarcane crushers; the only difference was that we threw away the juice, and boiled the stems, which, of course, is just the reverse of what the sugar men do, and our fame was great in the land. People came from far and near to see what the Sahibs were up to, and wondered whether it was true that the Bamboos from 350 square miles of forest were really going to be manufactured into paper. But, as already explained, that was not our object; otherwise the 25 bags of fibre produced would not have been consigned to oblivion, but, in part at least, would have been sent to England for Mr. Routledge to convert into paper.

The Moharli experiment proved conclusively that it would not pay to utilize the country sugar-mill for the manufacture of Bamboo Fibre; it did not prove, and did not attempt to prove, that with an improved rolling and crushing mill (with, let us hope, a stronger shaft than they seem to have had in Burma, and other requisite appliances,) the enormous and increasing quantity of spare Bamboos in that forest could not be utilized for the manufacture of paper stock. The fatal drawback will always be found in the unhealthy character of the Chanda jungles in October and November, the time proposed by Mr. Routledge for cutting the young Bamboo shoots.

It seems to me useless to answer Mr. Routledge's criticisms, though it would be easy to do so; he has evidently not understood the object of the experiment which, as far as it went and as far as it intended to go, was successful.

I remain, DEAR SIR,
Yours truly,
A. SMYTHIES.

THE

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Influence exercised by Trees on the Climate and Productiveness of the Peninsula of India.

Honourable Court of Directors' Despatch of 1847.

Para. 1. Pending the investigation by the House of Commons into the causes of the recent famine in Southern India, it may be useful to show what has been done since the Court of Directors wrote their Despatch, No. 21, of 7th July 1847.

2. In it the Court requested the Government of India to ascertain the "effect of trees on the climate and productiveness of a country, and the results of extensive clearances of timber." That an abundance of wood increases moisture, and that a deficiency promotes aridity, seemed to the Court clearly deducible from the researches and observations which had been made on the subject. The Court further observed that the decrease of moisture which has taken place in various parts of America has usually been attributed to the clearing of the forests, and where the country, as has sometimes happened from political causes, has returned partially to its original forest state, the contrary effect had been observed. As the removal of trees had been followed by great diminution of the volume of water in the rivers and lakes, the restoration of wood was succeeded by a corresponding increase in the quantity of water. The Honourable Court, however, went on to observe that the modes in which the presence or absence of trees influence the climate of a country are by no means so clear as the fact itself. It is generally believed that the clearance of trees is followed by a diminution of rain falling

in the country subjected to the process; further, it is considered that a part, at least, of the change effected by clearances may be attributed to increased evaporation, and it has also been suggested that the effect may be ascribed to the diversion of water to the purposes of cultivation. It seemed to the Court not unlikely that each of these causes may operate to a greater or less extent under different combinations of circumstances, and that two or three may frequently act together.

3. "The subject," the Despatch continues, "is one having a strong practical bearing on the welfare of mankind, and we are anxious to obtain extensive and accurate information in regard to it. We desire, therefore, that you will furnish us with any that you may possess, and that you will institute inquiries in such quarters as may be likely to lead to the acquisition of particular facts bearing upon the question. It has been suggested that the circumstances of the district of Azimghur afford some illustration of the subject, and we shall be glad to receive a correct report of any facts relating either to that district or others which may be calculated to throw light upon the subject of our inquiry."

Surgeon Gibson states increased aridity and temperature consequent on forest clearings.

4. Subjoined to the Despatch was an extract from a letter, dated 9th March 1846, from Surgeon Gibson, of the Bombay Medical Department. That officer was, for a prolonged period, Conservator of the Forests of the Western Presidency, and almost lived in the forest tracts. In the letter alluded to, he stated that the clearing then going on must, at no distant period, be injurious to the fertility of the adjacent garden and rice lands, and, indeed, of the country generally, with the further disadvantageous effect of a considerable increase of the annual mean temperature, and of the dryness of the climate. He mentioned that, since the South Konkan had been, to a great extent, denuded of forest, all the inhabitants concur in asserting that the springs had left the uplands, that the climate had become greatly drier, the seasons more uncertain, and the land less fertile; and, while in Canara, the exuberant moisture of the sea air soon

covers the denuded hills with a matted jungle of brushwood and small shrubs, the different climate of the upper country does not admit of this effort for speedy reproduction. The shoots from the felled trees remain green for a time, and on these perishing, or being cut away, the hills remain bare.*

5. Subsequently, in 1854, Surgeon Gibson sent me a letter to his address, dated Mahabaleshwar, 21st February 1846, in which the writer mentions the common belief in the Konkan that, with the removal of the wood, the small streams had more or less dried up.

Action taken by the Government of India.

6. The Government of India took immediate action on the Honourable Court's Despatch, (28th August, No. 780 of 1847) and asked the Madras Government for any available information respecting the effect of trees on the climate and productiveness of a country or district, and the results observed of extensive clearances of timber. In the usual course of business similar communications must have been addressed to the other local Governments, but the only reports made public were three from Madras. When I heard of the inquiry, I furnished a copy of a memorandum on the subject which I had written and published about the year 1840, and the Madras Government reprinted and distributed it widely, and sent it also to the Governments of Bengal, Bombay, and Agra, and to the Court of Directors (Minutes of Consultation of 8th September 1848). My memorandum subsequently appeared, extended, as an article in the Madras Journal of Literature and Science No. 30 of 1849. I had previously seen much of the Peninsula, perhaps few officers of Government have seen so much of it, and my memorandum commenced with the remark that, with the exception of a few localities in Southern India, the whole country seems destitute of trees. Whether they have disappeared under the hands of man while none were being planted to supply their places, or whether they never existed, nothing so much strikes the attention as their general scarcity; and, I added,

Assistant Surgeon Belfour's Memoranda of 1840 and 1848.

* This letter merits publication.

we cannot but look upon the cultivation of trees as of vital importance in such a country as India, where, under a tropical sun, the atmosphere is so likely to be loaded with miasmata, and the fertility of the land is so much dependent on the supply of water. The facts then adduced seemed to justify the conclusion that the foliage of trees greatly influence the purity, humidity, and temperature of the atmosphere, and the supply of water on the earth's surface, by attracting clouds and condensing the moisture in the atmosphere, diminishing local temperature, protecting the soil from the action of the sun's rays, and husbanding the rain by regulating its flow. Instances were given of injury following the denudation of the land, the increasing cost of firewood and of timber was alluded to, and I pointed to the famine in Bengal in the middle of the 18th century, when a third part of the population are said to have perished, and to that of 1839, when half a million are said to have died. The conclusions to which I came, from the information then before me, were that the bareness of the Bellary district is a cause of its aridity, also,—

and his conclusions.

(1.) That the extensive clearing of a country diminishes the quantity of running water that flows over its surface.

(2.) That it is impossible for us to determine at present whether the diminution is owing to a smaller annual fall of rain, or to increased evaporation of the surface water, or to these two causes combined.

(3.) That it is, however, shown, by the authors above quoted, that rain oftener falls and that more dew is deposited in well-wooded countries than when a country is naked; and, drawing our conclusions from the meteorological facts collected in equinoctial regions, we may presume that the extensive clearing of a country diminishes the actual quantity of rain that falls upon it.

(4.) That mountains, practically when covered with their native forests, by an electric action on the atmosphere, cause clouds to gather around them, condense

and collect the vapours of the air, and equalize the fall of rain.

(5.) That the forest trees which grow on mountain summits have a structure peculiarly fitting them to receive the waters of the clouds.

(6.) That lands destitute of the shelter of trees allow of more rapid evaporation.

(7.) That, independent of the preservation of surface water, forests husband and regulate its flow.

(8.) That, in all forest tracts, the temperature of the air is more equable throughout the year; that, in tropical regions, the atmosphere around trees is cooler, and contains more moisture than the air in the open glade; that the atmosphere of a tropical country, without trees, has an arid dryness in it, totally dissimilar to the cool softness of a well-wooded one; that lands covered with trees are cooler and moister than those which are exposed; that, in hot climates, the destruction of forest trees, by inducing aridity, destroys vegetation, and that forests and trees afford the shelter from violent winds which is absolutely essential to the health of the vegetable creation.

(9.) That springs draw their supplies from sources in their immediate vicinity, and the presence of trees, near these sources, seems to prevent the dissipation of the supply of water.

(10.) That, in clearings which are purely local, springs may disappear without there being any ground to conclude that the annual quantity of rain has diminished.

(11.) That the tenacious clayey undersoil, found in forests, is peculiarly adapted for preserving the surface and subsoil waters.

(12.) That there is a difference in the condensing power of trees, but by means of the vegetable creation, a valuable supply of moisture is collected from fogs, and from the atmosphere in the form of dew.

7. It had previously been recorded (p. 11) that trees, by

the nature of their respiration and radiation from their leaves in a sky without clouds, surround themselves with an atmosphere constantly cold and misty. They affect the copiousness of springs, not, as was generally supposed, by a peculiar attraction for the vapours diffused through the air, but because, by sheltering the soil from the direct action of the sun, they diminish the evaporation of the water produced by rain; that so soon as man, to supply his wants, has thinned or removed the trees which clothe the hill sides of the district he inhabits, the rain diminishes or rapidly runs off, the rivers dry up, and the previous fertility of the lands completely disappears; and, "by felling the trees that cover the tops and sides of the mountains, men, in every climate, prepare at once two calamities for future generations—the want of fuel and scarcity of water."

In a bare tract rivers and fertility disappear.

And I wound up these conclusions with the remark that, "if the facts detailed warrant these deductions, it may be confidently asserted that Southern India would be greatly enriched, and its climate ameliorated by the introduction of arboriculture; that only the Government, or the Civil Servants of the State, could accomplish anything on a great scale, but their efforts may be seconded by every individual resident in it, and the man who makes a few trees grow where none grew before will be a benefactor to this country," (pp. 47-48.)

Southern India climate improvable by arboriculture.

8. Since these views were made public in 1840 and 1848, the further information obtained has corroborated most of the conclusions to which I had then come, as I will now show. My letter was followed by one from General Cullen, on the 31st March 1849, which the Madras Government likewise made public. General Cullen laid great stress on the value of mountain chains in arresting and condensing the vapour of the atmosphere, and on the effect of forests during a great part of the year in preventing the dissipation of the superficial moisture, but he doubted if that circumstance could have much influence on the rainfall or on the supply of water from springs. Another letter, made public by the Madras

General Cullen's report lays stress on the value of mountain chains.

Government, was from Surgeon C. I. Smith, of the Mysore Commission, dated 23rd June 1849. In it, Dr. Smith records the belief of the people of Coorg and of the Superintendents of the Nuggur and Chittledroog divisions of Mysore, that the presence of trees in a country tends to increase the quantity of rain. He furnished three instances of the destruction of springs by denuding the ground of trees. One of these was in a range of hills south-east of Bangalore, at a coffee plantation called Glenmore, in the Debenaicottah taluq of the Salem district. The proprietor, when preparing ground for a coffee garden, which was watered by an excellent spring, was warned by the Natives not to clear away the trees in the immediate neighbourhood of his spring, but he disregarded their warning, cut down the trees, and lost his stream of water. Another instance was at the village of Hoolhully, about eight miles distant from the head of the new ghaut at Munzerabad. A planter had a nursery there, which he watered by turning on it a watercourse from a spring. He cleared up, for planting, the sides of the ravine in which the spring was, and ceased to have anything like the quantity of water he had before the shade was cleared. The same planter, close to the bungalow where there was a spring, had some years before cleared a ravine for planting, and found the water decrease in like manner; but, the coffee trees dying away, and the place being too small for a plantation, he did not renew them, and allowed the jungle to grow up again, since which the stream had nearly regained its former size. The Superintendent of the Nuggur Division also, at that time, wrote, "that springs of water shaded by trees, almost invariably dry up on trees being cleared away. This has been observed on the Neilgherry hills, and many other woody districts." Surgeon Smith further mentioned that in Coorg and the hill countries, it is impossible to move off the road when walking early and before the sun has dried the ground, the dews are so heavy and the dripping from the trees so wetting, yet the roads are perfectly dry.

Surgeon Smith's report instances injury from clearing.

Debenaicottah.

Springs dry up when deprived of shade.

Moisture from trees dripping, and from fog and dew.

In the north of Coorg, in December, and in Munzerabad, in January, he had found it impossible to move off the roads until the sun had dried up the dew with which the grass and brushwood in the jungles was daily saturated. On the Baba Booden hills, in April 1848, the hottest season of the year, he found the fog so dense till 8 or 9 A.M., and the condensation of water on the trees in the jungles so great, that he became wet through in moving among them.

9. These three reports from the Madras Presidency, by myself, General Cullen, and Surgeon Smith, so far as I know, are all that have ever been printed, and there has never appeared any report from any of the other Presidencies. If these have never been furnished, they might even yet be called for, merely for the sake of science, as the information existing is sufficient for the purposes of administration.

Madras Revenue officers' reports.

10. The Revenue officers of the Madras collectorates sent in reports, of which I was allowed to take copies, and I have those named on the margin,* and others on the forests of the Peninsula of India. The whole of the reports that have come before me bear testimony to the rapidity with which the forests have been swept away, particularly since the introduction of railways. Conservancy and planting should always have been continuous, but the instant that railways were resolved on planting operations ought to have been greatly extended.

* Canara, 31st August 1847.
Canara, 8th November 1847.
Rajahmundry, 6th January 1848.
Coimbatore, 6th January 1848.
Cotacamund, 26th January 1848.
Tanjore, 25th February 1848.
Kurnool, 29th February 1848.
Nellore, 4th March 1848.
Calicut, 4th March 1848.
Trichinopoly, 7th March 1848.
Bellary, 9th March 1848.
Arcot, North, 26th April 1848.
Salem, 10th May 1848.

Mr. Blane denounces the destruction of forests.

Mr. Blane, Collector of Canara, wrote in the most earnest manner from Mangalore, denouncing the Coomree, a destructive form of cultivation, mentioning that the forests had been largely destroyed and urging their preservation, pointing out the injurious effects produced on the climate and on the fertility of the soil by the extensive clearance of a country, and recommending a declaration of the right of the Government to all forests which cannot be clearly proved to be private property.

11. Mr. Henry Forbes, Sub-Collector of the Rajahmundry district, reported that the forest had receded, but he thought it open to question whether the diminution in the streams, which come from the hills, is not in the time which the stream takes to exhaust itself, instead of the body of water passing down to its bed, whether the rain is not said to be less in quantity only because falling on the hills, and no longer restrained by the trunks and roots of trees, and allowed no time to percolate through the soil and the fissures of rocks, and to supply the reservoirs of the springs, it pours down in torrents and leaves the watercourses dry as soon as the rain has ceased to fall.

Mr. Henry Forbes thinks the rain runs off more rapidly after clearances.

12. Mr. H. V. Conolly, Collector of Malabar, furnished the rainfall for 38 years, and mentioned that the amount had by no means lessened of late years, though the clearance of jungle land had been great. I reproduce this rain return on the margin, but rearranged in three portions of 13, 13, and 12 years respectively, and, as will be observed, it shows the considerable increase of from 122·88 to 130·10 and 141·33 inches in the three periods.

Mr. H. V. Conolly considers that the rainfall has not diminished.

Anjarakandy.		
1810 to 1822.	1823 to 1835	1836 to 1847.
Inches.	Inches.	Inches.
125·23	130·67	118·13
104·89	101·26	120·22
102·70	126·55	92·14
93·85	134·80	151·20
115·10	158·10	116·04
139·40	161·71	157·60
102·10	129·21	145·04
126·70	112·21	170·46
169·19	145·22	180·89
135·47	196·58	157·67
136·13	135·12	164·21
94·44	98·47	192·95
145·60	131·40	..
1597·60	1701·30	1695·95
122·88	130·10	141·33

13. The cultivators of Torriore and Volcondahpoorum stated to Mr. William Elliot, Collector of Trichinopoly, that so much rain had not fallen since the jungle between the Cusbah village and the adjacent hills was removed; that the heat and wind were much increased; their wells and tanks also had not yielded the supply they did formerly; that the place was not more healthy, and the dry cultivation was much increased. The ryots of Oodiarpalliam

Mr. William Elliot reports diminished rainfall and water supply and increased heat.

and Arrealore seemed to think that the removal of their small jungle had been productive of no evil, so far as the supply of water was concerned.

Mr. Binning reports lessened rainfall.

14. In North Arcot, Mr. Binning, the Collector, was informed that "the rains, for the last 20 years or more, had not been so copious or regular in that district as in former days," and that, of late years, the jungles and supplies of water had gradually diminished.

Mr. Lockhart reports drying up of streams.

15. The people of Salem told Mr. Lockhart that when the streams from the hills of Collymally, Tallamally, and Ninamally were covered with jungles, the water was continually running, but after the jungles were removed and the lands were converted into nunjah and totakal fields, by means of reservoirs, wells, and tanks, these natural streams had been affected.

Mr. Mellor reports aridity of Bellary district and contrasts Ramandroog.

16. The report from Bellary came from Mr. Mellor, the Collector, remarking on the extreme aridity of that district in contrast with the Ramandroog Hill, 3,100 feet above the sea, which was frequently, for some hours after sunrise, enveloped in a most dense mist.

17. I will here mention that the Ramandroog and Coomarasamy hills still contrast strongly with the arid plains of the Bellary district. When serving at Bellary in 1845—47, I was sent to Ramandroog to report on its suitability as a sanitarium. I lived on the hill for a time during the south-west monsoon. Looking westwards towards the valley of the Tumbudra, the fields might be observed bright with sunshine, but as the winds ascended the hill side, their moisture became more and more condensed, and as they swept like a thick mist over the edge of the plateau, the trees dripped as if under a heavy rain. Subsequently, in 1863-65, when again employed in the Ceded Districts, I twice revisited the hill, and had to bring to the notice of the Collector the great diminution that had occurred in the trees on its edge and sides, and to suggest the need of preserving them. At Bellary, during the south-west monsoon, clouds pass over so continuously

Denudation of Ramandroog hill side.

as to shade the sun for days, but rain seldom falls. The Copper Mountain to the south, over which the south-west wind passes, has not on it a tree which could break the motion of the wind, and I suggested to the Collector the need for planting it. There is no part of the south of India more in need of the paternal care of Government than the Ceded Districts.

Forests and woody tracts slowly but generally diminishing.

18. The question of the capabilities of the forests of Southern India for meeting the wants of the community was largely noticed in the Parliamentary Paper on the Porto Novo Iron Works (pp. 103, 150, 154—155, 162, 250, 263, 268, 277, 299, 312 to 321, 323 to 326, 338 to 340, 346, 361 to 364, 369 to 371, and 374), and when writing on the Iron Ores and on the Manufacture of Iron and Steel in the Madras Presidency (1855), I reported (p. 9) that there was "one fact shown connected with the best interests of this manufacture which merits the early consideration of Government. It is the slow but general diminution of the forests or wood tracts from which the smelters procure their charcoal. It is to be supposed that with the increase of population the forests in their vicinity would be cut away, but this (the Madras) Government and the Honourable Court are so fully alive to the necessity for foliage in a tropical country that it is only necessary for me to draw attention to the diminution going on, to have measures taken to secure for the country, and for the people themselves, therefore, that trees cut down for fuel should be as little wasted as possible."

Forest laws of Sweden.

I pointed out that the Swedish Government, in order to protect the fuel preserves, permit only a certain number of tons of iron to be produced yearly; and as, in that "country, 20 years are required for a new plantation to grow into timber, only a certain portion of the forest is allowed to be cut down annually and the spot replanted." And,

Replanting and protection needed.

now again writing after many years, I can only point to the necessity for replanting largely and carefully, and protecting the plantation throughout the tracts that have been denuded. Population has greatly increased, and public works and railways have largely augmented the demand for fuel and enhanced its price. Since

my report appeared on the Iron Manufacture, the Conservators of the forests have been continuously drawing the attention of the several governments to this point. Surgeon Gibson (Bombay Forest Report, 1849 to 1856, p. 5) reported that the charcoal used in the extensive iron works at Beypore had risen in price by upwards of 100 per cent., within the last few years, that (Report, 1857-58-59 and 1860, p. 115) owing to the vicinity and activity of the railway, the rise in the price of firewood, obtained from the side branches of trees, had been about 75 per cent., and the tendency was still upwards.

Fuel cost increasing everywhere in Bombay and Madras.

19. His successor, Mr. Dalzell, has mentioned (Selections from the Records of the Bombay Government, No. 76, p. 24) that, in Bombay, the price of fuel had risen from Rs. 3 to Rs. 8 per candy, or Rs. 24 per ton, and that Bombay was then annually burning 300,000 tons, of value, therefore three-quarters of a million sterling.

20. The Military Board at Madras during many years watched the Sriharicottah jungles which supply the Madras town with fuel. The Conservator (Madras Forest Report, 1859-60, p. 1) early reported that there were "many causes at work which are gradually thinning the ranks of the indigenous forests of the Madras Presidency, the first and by far the most formidable of these being railway requirements. It is, he says, scarcely credible the many thousands of large forest trees which have been felled in the neighbourhood of the various lines of railway within the past few years. But another source of diminution affecting only scrubby copse and minor forest, is the extension of cultivation consequent upon the reduction of the land tax and increased facilities of communication. There is every probability that the clearing both of the forest and jungle will go on so long as grain maintains its present tempting prices."

21. The records of the Government Central Museum, which I formed at Madras in 1850, and those of the Mysore Museum, which I formed at Bangalore in 1865, contain information worth examining as to the state of the forests and the timber and fuel supplies. In 1854 (1st July) I sent a

Madras and Mysore museums contain reports on the forests, timber, and fuel.

circular all over Southern India, calling for reports on its forests and woods (Appendix D). The reports came duly to hand, but the extent of work that devolved on me from 1855 was such as wholly to prevent me reviewing them. But, at that time, (Extract, Min., Cons., 3rd January 1856, Appendix C) the Madras Government had become fully alive to the waste committed in the valuable Government forests, and asserted that the whole of the forests of Wynaad belong rightfully to the Government in succession to the Pychee Rajah, but that private claims, founded on no good basis, had been allowed to spring up, and had, in some cases, been officially admitted, to the great injury of the rights of Government. The Collector was then ordered to report on the extent of the forests and the means to be adopted for preserving them. It would be of value to have that report made public.

Madras Government claim all Wynaad forests.

22. The progress of railways and of large public works was already causing the scarcity of fuel to be severely felt, and its price had risen 25 per cent. within a few years. (Report, Conservator of Forests, Madras, 1859–60, p. 14.) The fuel here alluded to was that used for cooking by Europeans, and a large proportion of the Native population, who also use bratties made of cowdung. In Bellary and other barren districts the firewood chiefly consists of branches of thorny bushes, there being almost a total absence of forest trees *(Ibid.)*. On the Neilgherry Hills peat or turf fuel had been brought to notice by Captain Campbell, of the 21st Regiment, Madras Native Infantry, and was being used more than formerly, thus lessening the demand for wood and charcoal. It is a matter of scientific interest to mention that the peat of the Neilgherries is different from that of Europe as regards the producing plants. Specimens of it and of peat brought from Tibet by Dr. Falconer were sent to the London School of Mines for analysis. Search might be made for other peat localities to meet the increasing requirements of a rapidly increasing population, who, having no mineral fuel, expend daily 2 lbs. of firewood per head, or the third part of a ton per annum.

Railways and Public Works have increased cost of fuel.

Peat fuel used in Neilgherries; its extended use recommended.

23. In the meantime the state of the forests of India had been attracting the attention of the scientific world. The British Association had appointed a Committee (Dr. Hugh Cleghorn, Madras Medical Department, Professor John Forbes Royle, King's College, London, Captain R. Baird Smith, Bengal Engineers, Captain Richard Strachey, Bengal Engineers) to consider the probable effects in an economical and physical point of view of the destruction of tropical forests. Their report appeared in the Proceedings for 1851 (pp. 78—102). It reviewed the existing information in the writings of Humboldt, Drs. Wallich, Wight, Helfer, and Griffiths, Captains Onslow and Harvey, Major Cotton, Messrs. Blundell, O'Riley and Seppings, and of my Memorandum of 1840—48, and it concluded by strongly urging the protection of Indian forests and the planting of trees.

Inquiry of British Association as to the effect of destroying forests.

24. Between 1860 and 1863, Mr. Justice Innes, of Madras, issued three pamphlets, one of them a letter addressed to Sir Strafford Northcote, Secretary of State for India, urging the importance of planting the hills with trees wherever a tree will grow.

Mr. Innes urges the planting of trees.

25. In 1863, Mr. N. A. Dalzell, Conservator of Forests, in the Bombay Presidency, furnished observations on the influence of Forests (No. LXXVI., Selections from the Records of the Bombay Government, p. 12), in which he showed that the wanton destruction of forests had entailed barrenness and aridity on countries renowned in former times for their fertility; that, along with woods, springs and rivulets disappear and cease to water the parched land; that the actual temperature of a country is, by the destruction of its forests, very sensibly increased; that the rain, gradually washing away the vegetable earth from the sides of the denuded hills condemns them to sterility, while these latter, no longer able to retain and regulate the flow of water that falls on their slopes, are scored by deep gullies, formed by impetuous torrents, and the beds of rivers are at one time dry and at another filled by sudden and short-lived floods. He urged (p. 22) the conservancy of every

Mr Dalzell urges conservancy, and prohibition of fires and duffes.

patch of forest in the country, the suppression of "dullee" or destructive cultivation, and the putting a stop to the pernicious practice of setting fire to the brushwood on the slopes of the hills and to the jungle generally.

26. Mr. Dalzell was here reproducing the conclusions at which previous writers on the subject had arrived, and the recommendations made by them.*

Mr. Robertson advises planting of groves and village fuel preserves.

27. It has recently been pointed out that Hindus of former days planted groves as acts of merit and made them over to the public. This might be revived. When Mr. Robertson, the Superintendent of the Government Farms at Madras, visited Coimbatore in the autumn of 1875, he found that during the last 30 years a large area of land had been denuded of trees, partly in view of an extension of arable culture, and partly to provide fuel for the railways and for domestic use. 700,000 acres, which were growing jungle scrub and coarse grass, had, during the preceding 18 years, been brought under the plough; and being now bare for two-thirds of the year, this must affect climate. The people unanimously declared that the rainfall had been gradually diminishing during the last 20 or 25 years, though it was not always referred to this cause. He was satisfied that the farmers would consent to plant trees in proportion to their acres, and he advised the formation of groves and village fuel preserves, the use of manure, and well cultivation, and deprecated the use of cow-dung as fuel, depriving the soil of it as manure.

Natives declare decrease of rainfall.

28. In consequence of the awful famine in the South of India in 1877, Sir Richard Temple was sent to the aid of the Madras Government. Writing as to the future of the Peninsula, he says: "We cannot but reflect whether the uncer-

Sir Richard Temple suggests that the seasons are more uncertain, and rainfall more precarious;

* Since Mr. Dalzell and the Honourable Mr. Justice Innes wrote, the general subject has been taken up by Mr. Marsh in "The Earth as modified by Human Action," by Dr. John Croumbie Brown, LL.D., in his "Water supply of South Africa, and facilities for the storage of it," and by Dr. Brandis in "Ocean Highways" for October 1872.

tainty of season, which often proves so disastrous in Southern India, is not becoming worse and worse; whether there may not be some physical causes at work to render the rainfall precarious; and whether such causes can be ascertained and obviated. It is hard to conceive a question more practically important than this. The discussion of it would be beyond the scope of this Minute. But, connected with it, there is one particular matter which may be mentioned forcibly, though briefly. The Southern Peninsula of India has been or is being denuded, not only of its forests but also of its jungles, its groves, its brushwood, its trees. The denudation has been, as I understand, going on near the sources and in the upper courses of the many rivers which water the country. This, perhaps, is being in some degree checked. But with the progress of coffee planting, and with the assertion of communal rights on behalf of the people, the utmost vigilance will be needed to keep it within bounds. If it were to proceed unchecked there would be needed to keep imminent danger of the rivers running dry, by reason of the catchment basins and the drainage areas near their sources being rainless. And as these rivers supply the great canal systems, this danger has only to be mentioned in order to be felt. The same argument applies in a lesser degree to the tanks or lakes which are second only to the canals in usefulness for irrigation. It has already been seen how precarious is the position of these reservoirs, even with one year's drought. The progress of the country causes the price of timber and of firewood to rise. The introduction of railways has, in the absence of any coal mines, greatly augmented the demand for fuel. Strong temptations are thus inevitably offered to the people at large to fell, cut, and lop recklessly, to bring every log, stump, and stick to market, to dig out the very roots of the jungle, so stopping any chance of reproduction, without thought for the future. There are stories to be heard everywhere of groves and hedgerows, and scattered trees being cut for sale. In the

The Peninsula has been, or is being denuded;

Catchment basins and drainage areas may become rainless;

Destruction continues, and Bellary and Kurnool treeless and shrubless;

midst of cultivated tracts, there are to be seen bare, *sterile hill sides*, said to have been forest clad within living memory. In such localities the climate is supposed to have changed for the worse. Beyond the Ghât mountains, in Bellary and Kurnool, the treeless, shrubless aspect of the country is as wonderful as it is melancholy. These are the very districts where famine has been occasionally epidemic, and where scarcity has been almost endemic. Any thoughtful

Scarcity and famines recur in them.

spectator must perceive that, according to all *meteorological* experience, and to the almost certain teaching of proved facts, these fine districts were not destined by Nature to be the prey and sport of famine and scarcity, but have been rendered subject to these calamities by the thoughtless action of man. Even the numerous groves planted in the last generation by Mr. Robertson, whose name is still a household word, were made over many years ago to the villagers, and have been mostly cut down. Trees, jungle, and forests must, indeed, be thinned and cut for the use of man, but they need never be exhausted, and something might always be left for reproduction. There is, of course, a Department of Forest Conservancy in the Presidency, and much good is done thereby. Whether its functions and proceedings are fully sufficient for the wants of the country is a question not to be discussed here. At all events, there is reason to hope that the waste lands in hill and dale,

He counsels conservancy and planting.

which are in this Presidency so extensive, might be kept much more thickly wooded than they are, and that large areas, now quite naked and devoid of vegetation, would, if reserved and guarded, become again covered with trees and brushwood, as they were in former ages. And the successful efforts of individual officers in the past prove what may yet be effected in this way of planting. If the necessity be duly recognized, then there is no doubt of the possibility of devising remedies."

29. The meteorological data available are, however, opposed

South India seasons are not more uncertain than before, nor is the amount of rain lessening or seasons more precarious.

to Sir Richard Temple's belief that there is any increased uncertainty in the seasons of the south of India, or that the rainfall is either lessening or more precarious than before. But man, by denuding the land of forests, is allowing the rain-water to rush off the surface, sweeping away with it the mould, breaking down the tank dams, starving the springs, and draining off the waters of the springs, rivulets, and wells. At page 8, I gave, in three columns of 13, 13, and 12 years respectively, the rainfall at, Anjarakandy in Malabar, from 1810 to 1847, and showed that the rainfall had certainly not diminished there, the average of each of the three periods having been 122·88 inches, 130·10 inches, and 141·33 inches. I now furnish 60 years of monsoon rainfall (May, June, July, August, September, and October) in Bombay, from 1817 to 1876, arranged in periods of 15 years, in which the averages were 81, 70, 77 and 79 inches respectively, the average of the 60 years having been 77·04 inches.

Rainfall in Malabar has not diminished.

Bombay City Rainfall in Monsoon Months for 60 *years.*

Nor has that of Bombay diminished or become more uncertain.

1817 to 1831.		1832 to 1846.		1847 to 1861.		1862 to 1876.	
Year.	Inches.	Year.	Inches.	Year.	Inches.	Year.	Inches.
1817	103·60	1832	74·09	1847	67·31	1862	76·56
1818	81·14	1833	71·39	1848	73·42	1863	80·33
1819	77·96	1834	70·47	1849	118·88	1864	56·60
1820	77·34	1835	62·61	1850	51·15	1865	73·46
1821	82·59	1836	87·99	1851	106·14	1866	99·39
1822	112·22	1837	64·58	1852	75·46	1867	73·57
1823	61·70	1838	50·78	1853	69·65	1868	78·43
1824	93·97	1839	73·62	1854	99 79	1869	115·39
1825	72·24	1840	69·15	1855	85 10	1870	81·06
1826	78·17	1841	71·49	1856	71·08	1871	47·20
1827	81·03	1842	95·16	1857	79·28	1872	87·61
1828	121·98	1843	59.27	1858	61·90	1873	87·42
1829	65·65	1844	65·40	1859	81·84	1874	93·56
1830	71·89	1845	54·73	1860	74·65	1875	88·08
1831	101·83	1846	87·48	1861	106·08	1876	58·93
Total.	1,223·28	.....	1,052·21	.....	1,181·68	.....	1,190·59
Aver. age	81·55	.....	70·14	.....	77·44	.....	79·87

30. In the first period the range was from 33·97 to 121·98, or a range of 88·01 inches.

„ second „ „ 50·78 „ 95 16, „ „ 44·38 „

„ third „ „ 35·10 „ 118·88, „ „ 83·78 „

„ fourth „ „ 47·20 „ 115·39, „ „ 68·19 „

31. The Anjarakandy register shows an augmented rainfall, that of Bombay town shows a decrease of only 2·22 inches in the last compared with the first period; practically there was no falling off.

32. The last and most important statement obtainable is from the Madras Register, from the year 1813 to 1876, a total of 64 years.

Madras City Rainfall for 64 *years, in four periods of* 16 *years each.**

Madras rainfall has not diminished, and the seasons are not more uncertain than formerly.

1813 to 1828.		1829 to 1844.		1845 to 1860.		1861 to 1876.	
Year.	Inches.	Year.	Inches.	Year.	Inches.	Year.	Inches.
1813	45·11	1829	33·87	1845	38·05	1861	37·19
1814	32·41	1830	32·43	1846	79·81	1862	86·18
1815	56·00	1831	44·35	1847	80·99	1863	54·61
1816	41 16	1832	18·45	1848	54·76	1864	47 23
1817	63·56	1833	37·11	1849	39 81	1865	41·64
1818	76 25	1834	39 00	1850	36·88	1866	51·39
1819	36·33	1835	41·47	1851	64·32	1867	24·37
1820	70·01	1836	44·76	1852	72·89	1868	41·43
1821	47·13	1837	49·26	1853	35·82	1869	32·31
1822	69·61	1838	52·33	1854	43·20	1870	74·10
1823	26 62	1839	53·07	1855	32·32	1871	56·35
1824	33·72	1840	58·65	1856	46 99	1872	73·87
1825	56·05	1841	58·32	1857	52·95	1873	51·83
1826	60·73	1842	36·48	1858	48·50	1874	62·90
1827	88·41	1843	50 28	1859	55·14	1875	37·12
1828	37·89	1844	65·36	1860	27·64	1876	21·49
Total.	830·99	.....	718·17	.....	809 87	.....	745·81
Average.	51·53	.....	44·88	.....	50·61	.....	46·61

33. I have arranged the registered data into four equal periods of 16 years each, and while the total of 64 years averaged 48·5 inches, that of each of the respective periods was 51·53 inches, 44·88 inches, 50·61 inches, and 46·61 inches, and the variations were—

in the first 16 years, from 26·62 to 88·41, or a range of 61·79 inches.

„ second „ 18·45 „ 65·36 „ 46·91 „

„ third „ 27 64 „ 80·99 „ 53·35 „

„ last „ 21·49 „ 74·10 „ 53·61 „

* "The Cycle of Drought and Famine," Dr. W. W. Hunter, p. 21, Appendix A.

34. These registered data show that the rainfall in latter years has not been more precarious than before, that the uncertainty of the seasons has not increased, and that the amount of rain falling has not diminished.

Madras drought increased from clearings of jungle.

35. A writer under the pseudonym of "Philindus"* has arranged the rainfall at Madras town from 1813 to 1875, into three periods, *viz.*:—

	Average inches.
From 1813 to 1833	... 47·63
„ 1834 „ 1854	... 50·71
„ 1855 „ 1875	... 47·04

and, he says, "consequently the clearings of jungle which have been made during the past three quarters of the century have not affected the total quantity of rain falling, and as the physical effects of drought have absolutely increased in intensity, this increase must be attributed to the removal of those conservative influences which former aspects of the country possessed" (p. 248.)

Ryots prove clearings cause aridity.

36. The ryot cultivators have had no doubts as to clearing being the cause in operation lessening their water supply. Surgeon Gibson (Bombay Forest Report, 1849-56, page 7) prominently mentioned their views when he was writing regarding the former and recent conditions of the Jyghur Creek, near Rutnagherry. He says, what we now see are merely shoots from the stocks of the old trees. It is, indeed, probable that extensive woods have at one time existed here, as the sheltered sides of the Jyghur Creek, for at least 30 miles from its head, are continuous, well shut in, and not destitute of soil. Under our system of exhaustion without replacement, the sides of the hills enclosing the well shut in valleys are now bare, having been mostly denuded of even the gnarled stocks from which the annual supply of branches for field burning is cut. He tells us that he inquired of many of the cultivators who own the level holms skirting the creek, whether they experienced any difference in the supply of water from above since the wood has been

* "Macmillan's Magazine" for January 1878.

cleared off, and the universal reply to these inquiries (made at different places from separate persons) was, that now the water came down in a lump, leaving the upper lands and the holm fields arid in the dry season, whereas, in former years, the supply was more gradual and more permanent.

37. For several years past, eminent microscopists have been carrying on in India inquiries similar to those in which Max von Pettenkofer has been engaged. That learned man has recently been writing on the influence of trees in preventing evaporation, also on the purity of the atmosphere, and as to surface and subsoil water. His observations are of so much importance at the present moment that I give extracts from them here. He says:* "The amount of moisture in the soil of a forest is subject to considerably less variation than that outside. Ebermeyer has deduced the following result from his meteorological observations: 'If *from the soil of an open space 100 parts of water evaporate,* then from the soil of a forest free from underwood 38 parts would evaporate, and from a soil covered with brushwood only 15 parts would evaporate.' This simple fact explains clearly why the cutting down of wood over tracts of country is always followed by the drying up of wells and springs.

Von Pettenkofer states trees check evaporation, regulate the moisture in the soil,

and on cutting down, wells and springs dry up.

"Surface vegetation has also other advantages; besides its use in regulating the moisture in the soil, it purifies it from the drainage of human habitations, whereby it is contaminated and impregnated. If this refuse matter remains in soil destitute of growing vegetation, further decomposition sets in and other processes are induced, not always of a salubrious nature, but often deleterious, the products of which reach us by means of air and water and may penetrate into our houses.

Vegetation purifies the air and water.

"We learn," he says, "from Ebermeyer's work, that the temperature of the trees in a forest, and even in the tops of them, is always lower than the air in a forest. The shade of a single

Trees are cooler than the air, and shelter the soil.

* "Contemporary Review," December 1877, pp. 93—81.

tree, therefore, cools, not only by intercepting the sun's rays, but also by the effect of gentle fanning. The shelter of a thick wood is cooler than that of an open space exposed to the sun. The air from outside is drawn into the wood, is cooled by it, and cools us again. And it is not only the air that cools us, but the trees themselves. Observation has shown that the trunks of trees in a wood breast high, even at the hottest time of the day, are five per cent. cooler than the air."

Facts accumulated in past 30 years.

38. Thirty years have passed since the subject was first brought under the consideration of the Indian Government, and in the interval many additional facts bearing on it have accumulated. But the information they supply is identical in character with that furnished at the outset, and would have justified wide action to protect the country and its people from ever recurring droughts, scarcity, and famine. After the reports from the Madras officers were received, orders were issued to conserve the forests, to plant trees, and to protect the springs. Conservators of Forests were appointed in all parts of British India, and in, at least, one allied State, that of Hyderabad, in the Deccan. In October 1877, there were 100 officers of the Conservator grades, and 86 Forest Rangers. On the Neilgherry Hills a rule was enforced prohibiting felling *within 10 yards of running water (Appendix A), and a native* who contravened it was fined by the Collector of the district. An Act was passed for the control of the forests, and in 1877 (17th October) an amended Act was, with the approval of the Home Government, submitted to the Legislative Council of India, Mr. Hope, remarking (p. 512) that "without effective regulation and conservation of forests, not merely the public revenue, but the public themselves, would suffer, and even risks of famine would be infinitely incurred."

Action taken by Madras Government.

Forest officers appointed and forest laws passed.

Returns of replanting to be called for.

39. There has never, so far as is known, been any general return published showing the extent to which replanting has been carried. This should now be obtained, and continued

annually in future, because, by the latest information, the existing forests are receding. Also, the planting seems not to have had in view the regulation of the rainfall, but to have been of trees suitable for timber, and I have not heard of any attempt to clothe any of the denuded hills in the Ceded Districts or elsewhere. Private persons have speculated in fuel plantations in several parts of the country. Along the Coromandel Coast, casuarina trees were largely laid out; planting was made in some places along the lines of railway and in the Mysore country, and some years since a person, writing from Aurungabad, mentioned the case of a man who, by a trifling outlay, had planted a portion of waste land, and been able to leave a large fortune to his family. Madras reserved forests area is estimated at more than 5,000 square miles.

Private persons form fuel plantations.

40. Only the Governments of India, however, can obtain results commensurate with the requirements of the country, and the need for action is urgent. Dr. Robert Wight gave his views on these points when writing in 1850.* He remarked that, "for some time past, the opinion has been gaining ground that the climate of a country is considerably influenced by the greater or less extent to which the surface is covered with arboreous vegetation, and that the dryness of the climate of the Carnatic is, in part at least, attributable to its being so generally denuded of forest. To remedy this evil, extensive planting has been authorised. This proposal is worthy of a great and paternal Government, and deserving the highest commendation, for, even admitting, as some supposes, the theory to be erroneous, still an abundant supply of good timber, adapted for all purposes, will, exclusive of the augmented fertility flowing from the retention of moisture in the soil and the shelter plantations afford, add incalculably to the resources of the country and be of such *especial advantage* to the Carnatic—where timber and fuel are in great request

Government alone can plant commensurately with the country's wants.

Dr. Wight suggests sheltering by planting.

* "Proceedings of the Madras Central Committee for the Great Exhibition of 1851," p. 190.

and shelter from the scorching blasts of the land wind much wanted—as to justify a very liberal expenditure towards attaining so great a boon to the country. Orders having been issued for carrying into effect the plan proposed, it then becomes an important question what kind of trees should be planted? Should large-headed rapid-growing ones be selected as those likely to produce the speediest effect on the climate, or ought those furnishing the best timber and fuel, and, therefore, economically the most valuable to the country, to have the preference? The last, of course, will be those to which the greatest favour will be shown, but they cannot be exclusively taken, it being necessary, on the known principles of vegetable physiology towards ensuring success, that the plantations should be of a mixed character, and must, to some extent, include bad as well as good, but the majority should be of the latter description."

and indicates the trees.

41. Thus wrote Dr. Wight 28 years ago. But, while carrying out his suggested principle of variety, two distinct kinds should, invariably, be brought together—one of fast growth to shoot up and shelter, the other and more lasting slow growing trees. The Committee of the British Association enumerated several trees which they deemed desirable to have planted; amongst others, the (1) Mango, (2) Banyan, (3) Pepul, (4) Tamarind, (5) Dhak, (6) Wild Jujube, (7) Babul, (8) Seriss, (9) Sissoo, (10) Teak, (11) Bamboo,* all of them useful, and such as may be largely planted. Plants with large, tough, thick, glossy leaves, condense the vapour in the atmosphere more rapidly than any others. The portia tree (*Thespesia populnea*) drips abundantly in a morning fog. The various neem trees, species of *Azadirachta* and *Melia*, are in full foliage in the very height of the hot weather. It is in the hottest season of the year, March and April, that the mango tree throws out its blossoms and young leaves, maturing its fruit in June. The several species of *Eucalyptus*, from Australia, grow with

Two kinds of trees needed, a fast and a slow growing.

Trees named by British Association.

* These are the (1) *Mangifera Indica*, (2) *Urostigma Bengalense*, (3) *Ur religiosum*, (4) *Tamarindus indica*, (5) *Butea frondosa*, (6) *Zizyphus Jujuba*, (7) *Acacia arabica*, (8) *Albizzia Lebbek*, (9) *Dalbergia Sissoo*, (10) *Tectona grandis*, (11) *Bambusa* species.

great rapidity on the Neilgherry Hills, and may be largely utilized. Some plants, like the cooltee, (*Dolichos uniflorus*) are brought forward in the cold season of the year by the night dews.

Protection for growing plants needed.

42. Philindus says (p. 253), the cost of planting by the Madras Forest Department during 1874—75, was (excluding teak) about 5*l.* per 1,000 trees, and he mentions 80,000 square miles as about the area requiring to be planted with trees. Protection for the growing plants is, also, a great present and future need. The earth has in its bosom myriads of seeds and roots which would shoot and grow into trees, and shrubs, and grasses, if man and the flocks and herds would only permit. It is wholly unnecessary to experiment on this point, for I know that protection would effect a great and immediate change; but if any doubts on the subject be felt, the south-west monsoon begins in three months, and a strict conservancy may be established in several hills in various parts of the country, and the result reported at the close of the south-west monsoon, and again when the north-east monsoon is over. In the meantime plants and seeds can be gathered in from all parts. I think that no species of the pitcher plant grows in the peninsula. It may be doubted if there is in the south of India a dozen of the travellers' tree, though the plantain (*Musa paradisiaca*) grows wild in the Western Ghats.

43. A writer in "Science Gossip" says that, "from observations by M. Fautrat, relative to the comparative influence of leafy woods and resinous woods on rain, and the hygrometric state of the air, recently communicated to the Paris Academy, it appears that pine forests have a much greater influence on the hygrometric state than others; so that if the vapours dissolved in the air were apparent, like fogs, we should see forests shrouded in a large screen of moisture, and in the case of resinous woods, the vapoury envelope would be more distinct than in that of leafy woods. M. Fautrat also shows that pines retain in their branches more than half of the water which is poured upon them, whereas leafy trees allow 58 per cent. of the precipitated water to reach the surface of the ground. He suggests, therefore, that in planting with a view to oppose

M. Fautrat names the trees most useful.

inundations, it would be advisable to choose by preference resinous trees, as offering a better covert."*

Dr. Brown notices the important trees.

44. This point, however, appears to need some further investigation. Dr. J. C. Brown seems to be of opinion that some trees evaporate and some condense moisture. He notices the tree of the Ferro Islands which attracts a cloud and drips, and another tree in Asia Minor with similar action, and mentions† that in Europe the most copious humidity or moisture has been produced by the elm, and in decreasing order by the poplar and horse chestnut, whilst the least effect is produced by the firs.

Mr. Robertson's experiments on the absorbent capacity of soils.

45. In connection with this subject, I may draw attention to Mr. Robertson's renewed experiments on the absorbing and retentive powers of soils. The regur, or black cotton soil of India, is familiar to all who have been in that country, and it is reckoned one of the best of the soils. During the dry season it rends into great cracks in every direction, but, during the rainy season, it presents a uniform glazed surface of black tenacious clay, marching over which is an impossibility. Why the great rents become thus closed is shown by Mr. Robertson's experiments to be owing to the great capacity this soil possesses of absorbing and retaining moisture. He

Black cotton soil absorbs largely, and is highly retentive;

tells us (p. 35) that it is capable of holding more than one-third of its entire weight of water, and that it has, in a very remarkable degree, the power of absorbing moisture from the air. In one night black soil absorbed 1¾ per cent. of water, but sandy soil only ¾ per cent. And in another experiment he found that thoroughly dried cotton soil, exposed to an atmosphere saturated with moisture, absorbed 7·99 per cent. of water during a night. Drs. Macleod and Christie, Captains Allardyce and Newbold, all noticed this character in the black cotton soil.‡ It is that

its great value for cold weather crops.

in which the cottons, the sorghum, the wheats, and maize are grown. In many

* "Hardwicke's Science Gossip," No. 158, February 1878. "The Influence of Trees on Rainfall."

† Dr. John Croumbie Brown, LL.D., "Forests and Moisture," Edinburgh, 1877, p. 37.

‡ "Madras Journal of Literature and Science," October 1855, p. 472.

parts it is 15 and 20 feet deep, and probably it might be largely used as a layer over the less retentive and less absorbing soils. Manure is not available in that country in anything like the needed quantities, and water in many of the higher lands cannot be readily or cheaply provided, but there cannot be any difficulty in covering the red, and grey, and calcareous soils with a layer of the black soil. It is to be had in almost every part of the inland country, in smaller or larger quantities, and covers the whole surface of the greatest outburst of volcanic rocks in the world, in the western part of the Deccan, Central Provinces, and Berar.

46. The ryot rarely provides pasture fields for grazing. In the immediate vicinity of large towns, patches of *Sorghum vulgare* (juari, cholum), sown thick to furnish green food, may occasionally be seen, but the usual custom is to drive the horned cattle, the sheep, and goats, to pick up what they can get on unoccupied or fallow tracts. In this respect the practice in India is virtually the system of the sheep runs of Australia, where, however, four acres are allotted to a sheep, and in India everything disappears under the numbers of the flocks and herds, and, in the vicinity of towns and villages, horned cattle and pigs eat up refuse greedily. I write from memory when I mention that in the open parts of Australia four acres per each sheep are required for the suitable rearing of a flock. In the summer pastures of England, between London and Bristol, an acre is necessary for one of the horned cattle with two sheep, but Philindus calculates (p. 255) that on every available acre in the Madras Presidency there are 1·6 horned cattle, 1·35 sheep, and 2·7 goats.

Pasture fields required; also grasses sown.

47. Also, throughout all India, besides the destruction of much grass by the close cropping of the flocks, much is destroyed by the mode in which fodder is obtained for horses. The valuable hariáli grass (*Cynodon dactylon*) grows abundantly over most parts of the country, but all through the hot weather, when herbage disappears, its very roots are dug up to provide fodder for horses. Deprived of all vegetable covering, it is not to be wondered if the earth dry up. The day must come when pasture fields will be laid down for the herds, and their early

adoption should be encouraged. Already, in New Zealand, grass seed has been introduced from Great Britain, and it is said thrice as many sheep are now being fed on an acre. Moorcroft recommended a trefoil which he found the people of High Asia using for their cattle. There are, however, plenty of grasses from which to select, and consciousness of the necessity for using them alone is wanting. The farmers of India and the villagers generally are, however, wasteful in many ways, and they might seemingly make much more of the natural grasses than they do at present.

48. Mr. Robertson has pressed this point, and Major C. McInroy, the officer in charge of the Amrut Mahal Cattle Breeding Establishment at Hoonsoor, in Mysore, remarks that Mr. Robertson's belief regarding the mismanagement of grass lands by ryots tallies completely with his own experience. He says: "It is lamentable to observe the wanton destruction of pasture on the one hand, and on the other the apathy displayed by the natives in securing the enormous quantities of excellent jungle grass which is annually burnt or otherwise lost. I cannot even get surplus kawal grass cut and stacked on the condition of giving the workers half of it for their own use. With a gang of Tamil coolies at my disposal, and the use of the Government elephants, I could stack any quantity. No doubt," he adds, "the increase of cultivation has diminished the waste lands formerly used for grazing, and eventually this will become a very serious question, but in the meantime, and for many a year to come, there ought, with the most common care and forethought, to be ample grass for the present needs of five times the number of cattle in the country, and to provide a reserve of hay for such seasons as the one through which we have just passed."*

and the existing grasses more utilised.

49. Mr. Robertson mentions that in the Coimbatore District a few of the villages retain in their vicinity lands for pasturing their flocks, but take no care over the grasses growing on them, which are perennial and in tufts.

* "Pioneer Mail," 16th February 1878.

Firing of forests and hill tracts should be sternly prohibited,

50. The pastoral races annually fire the grass and under-shrubs in all the forest and hill tracts where their herds and flocks graze. The extent to which this is practised, and the distances of the places affected by it, are scarcely to be realized by Europeans. On one occasion on the Irawadi, near Prome, I observed flakes falling on the deck of the steamer from forests burning, it was supposed, miles away. On two of the occasions of my sailing through the Malay Archipelago, I saw the forests of whole islands on fire. On one occasion, when travelling from the Woon to the Bassim district of Berar, the whole of the hill summits around me, so far as the eye could see, were on fire. The destruction by such firing of young trees and shrubs is an annual recurrence, and it should be sternly repressed.

and protection given to growing plants.

51. It will be necessary to exclude wood-cutters, cattle, and sheep and goats from tracts allotted for the growth of trees, or underwood, or grasses. Darwin* strongly urges the need for preventing cropping by cattle, and for enclosing tracts on which it is desired that trees should grow.

Sun's rays needed for the winter crops.

52. Throughout nearly all the interior of the peninsula of India, from Bangalore northwards to Nagpore, the winter crops are reaped in January, February, and March. The fields have no permanent enclosing hedges or trees, but the cultivators annually enclose the road side parts of their holdings with branches of the babul tree (*Acacia arabica*) which they burn when the crops are off the ground. They do not wish to have hedges or trees, as those tracts are 1,300 to 2,400 feet above the sea, and the crops of the winter season need all the sunshine they can get. Whilst the crops of sorghum, wheat, &c., &c., are on the ground, no sight can be more lovely, but when harvest is over, the view is one of desolation. A traveller, who recently came to Madras at the bare season of the year, remarked that he had come to the world's end; another, who saw Berar at the close of the harvest, said it was the most God-forsaken country he had seen;

* "On the Origin of Species," 3rd Ed., pp. 74, 75.

and a third traveller from Europe was at a loss to understand whence the Government drew their revenue. It will not, I think, be possible to induce the cultivators to have hedges or trees at the sides of fields where cold weather crops are grown, but there are abundance of unoccupied places which could be advantageously planted with trees and shrubs.

Shelter from hot winds needed for growing plants and tanks.

53. Shelter from dry hot winds is needed for all growing plants and to prevent desiccation. A dry wind causes very rapid evaporation; a hot dry wind, in a few days, will lick up all the moisture on the surface of the ground, which cracks and rends under the drought, and shallow tanks dry up; the bottom becomes heated under the sun's rays, evaporation rapidly proceeds, and a hot dry wind blowing over the surface carries off the rising vapour. All tanks should be girt with trees on the sides from which hot winds blow. It is not required to have a great number of trees. A quarter of a mile of a tank under lea of a single tree, 16 or 20 feet high, will lie unruffled by the wind.

Non-Aryan races are field labourers and should be made farmers and holders.

54. The communal system of British India presents difficulties in the way of settling the non-Aryan races on the waste lands of villages. These classes form the chief part of the agricultural labourers. Although in many districts there are customs current which prove that the non-Aryans were settlers prior to the appearance of the present Hindu holders, only at one Deccan village, and that in the Hyderabad dominions, have I ever seen a village patel of the Dher or Pariah caste. Many of these races are migrating, even to distant countries, in search of employment and food from which the communal rights of the Hindu holders are debarring them. Yet India cannot spare its population, and its lands could support much larger numbers than now. But the non-Hindu population of some districts is increasing with such rapidity that they are emigrating; and, as the provision of more food is even now a question of importance, the attention of Government might be given to devising means by which non-

India population generally sparse, and country could support greater numbers.

Aryans could hold land. Oudh, Bengal, and the North-West Provinces are well peopled; but other districts have only a scanty or even a sparse population, as the following memorandum of the number of souls on each square mile will show:—

Oudh	468	Berar	129
Bengal	397	Ajmir	119
North-West Provinces ...	378	Assam (excluding Hill Tracts)	99
Madras	226	Central Provinces	97
Mysore	187	Coorg	84
Punjab	173	British Burma	81
Bombay	131		

Peninsula is sparsely peopled.

And, in the Madras Presidency, the average number of persons to the square mile are as under:—

Madras City	14,724·1	Coimbatore	237·3
Tanjore	540·1	South Canara	235·4
Malabar	376·7	Ganjam	182·9
Arcot, South	360·3	Kistna	180·7
Trichinopoly	341·5	Nellore	162·7
Chingleput	340·7	Cuddapah	161·5
Tinnevelly	327·3	Bellary	151·5
Arcot, North	282·8	Kurnool	130·4
Salem	262·9	Vizagapatam	117·7
Godavery	255·9	Neilgherry Hills	66·0
Madura	238·5		

55. These figures are instructive. Tanjore, prior to British supremacy, possessed large irrigation channels leading from the Cauvery and Coleroon, and these were improved by Colonel Sim and Colonel Cotton. It now supports a larger population than any other Madras district, and the three revenue districts, Bellary, Cuddapah, and Kurnool, into which the Ceded Districts have been arranged, stand out in strong contrast to it. These three, with one exception, are the scantiest peopled, and are the most arid of all that southern region. To remedy the want of humidity, the waters of the Tumbudra might be more largely utilized than they yet have been. It is the great river of the Bellary and Kurnool collectorates; but, running as it does through a greatly denuded country, channels and reservoirs are both required, for there is now neither tree nor shrub, nor grass on the bare stony hills to retard and

Tanjore, the most irrigated, is best peopled. Ceded Districts, the most arid, are amongst the least peopled and most denuded, and irrigation channels and reservoirs needed.

Tumbudra river bed has dangerous rushes or dry.

equalize its flow. At one time it is in rapid, even dangerous, flood; at another its bed is dry; it comes down past Kurnool with sudden rushes. My house was built on the brink of the right bank, and in 1847 (or 1848) a woman, whom I saw crossing on foot its almost dry bed, was overtaken by a wall of water and drowned. Its waters are abundant; its catchment area is about 20,000 square miles, and its flood discharges at Kurnool 270,000 cubic feet per second. When the Madras Irrigation Company planned their great work on the Tumbudra, they had also in view a further irrigation scheme, and expended, as was mentioned to me, Rs. 40,000 in taking the levels of a tract through the Bellary district from higher up the river than Sankosala, the head of the Kurnool scheme; but, not seeing their way to complete another canal, they transferred their surveys and plans to the Madras Government. If my information on this point be correct, the projected canal scheme could now be resuscitated, seeing that irrigation channels and reservoirs are largely needed in that arid region. That Company planned their canal to combine an irrigation and navigation channel. It is a grand work, overgrand for the state of the people, for the minimum section of the canal in the first 75 miles has a 90-feet bottom breadth, and the great desideratum in the Ceded Districts is irrigation. To aid in providing this, the prominent hills in the Bellary district should be guarded, and the entry on them of wood-cutters, cattle, or sheep, also all burning of grass, strictly prohibited. There are many hills in the district on which grass and shrubs and trees would shoot up, if cropping, and cutting, and burning were prohibited; groves also could be planted successfully in many places, and all three districts so improved as to support a larger population than 150 to the square mile, as now. The Ceded Districts have been great cholera seats, and Von Pettenkofer would point to the want of plants as a probable cause.

Protect its hills from wood-cutters and all cattle and fires.

56. Besides the settled non-Aryans, there are, in all parts of India, numbers of homeless races; in the Tamil, Telugu, and Kanarese countries, not fewer, perhaps, than 100,000. Their

Non-Aryan races to be settled and made producers.

history cannot be traced, but they are contributing nothing for the support of themselves and others; indeed, most of them are predatory. They are not inclined to mix with their fellow men, and tact and patience will be required to withdraw them from their migratory habits, and induce them to settle down to agricultural pursuits and become producers. Surgeon-Major Shortt, of the Madras Medical Department, was able to initiate this good work with one of the races on the East Coast, perhaps the most suspicious of all. In connection with this it may be mentioned that, from the year 1860, the question how to people Burmah has been constantly under consideration, and unsuccessful efforts to induce immigration have been made; yet non-Aryan races are pressing into Assam to obtain culturable lands and a milder climate whom a second Cleveland could lead to the unoccupied tracts in the south, and much of the restlessness of the frontier tribes is the result of their cramped position and natural craving for more land and more food, and their strivings to obtain these can never be permanently repressed.

Frontier tribes pressing in for lands and milder climate, and cannot be permanently repressed.

57. Also, any efforts which the Government of India may make to conserve the forests, and protect the springs and river sources should not be restricted to British territory or to Government forests, but allied and feudatory States likewise should be asked to introduce conservancy and planting. Already rules exist for controlling private forests, but there has still to be introduced a system for the protection of the forests in Native States where many rivers have their sources.

Forest laws should be introduced into allied States.

58. To bind down the moving sands from river beds, and sea shores, and deserts is also a matter meriting attention, in order to prevent the submersion of arable land. Something might be done for parts, at least, of Rajputana, and for parts also of the Indian deserts, by providing irrigation channels and reservoirs, and by planting sand binding plants. A recent writer mentioned* that "at the extreme north of the district of

Moving sands to be bound down; Jacobabad an illustration.

* "High Asia," Part I., Vol. II., page 3.

Jacobabad, in the vicinity of the outposts, is desert plain, breaking occasionally into sand hills, but the cultivation is gradually reclaiming this land, and there is every prospect in a few years, as the canals are opened out in this direction, that the present barren, desolate appearance will be changed for fields of corn." This seems to have been the state of that cantonment until the year 1844, when a canal was led into it from the Indus, and Dr. Brandis, writing in 1872, at page 95 of "Ocean Highways," mentions that now the plain is a dense forest of babul and other trees, upwards of 60 feet high, sheltering the houses and gardens. He tells us that "a ride of a few miles takes you into the desert which skirts the hills of Baluchistan, a level plain of splendid, fertile, alluvial soil, but hard, naked, and barren like a threshing floor, without shrub, herb, or grass, except in the vicinity of the canals, where vegetation is rich and luxuriant." There are many lands in the south of India needing a similar care to that given to Jacobabad.

Conclusion. Rainfall is as abundant as ever, but reckless denudation has removed the means of regulating its flow.

59. When writing in 1840 and 1848, the data available justified the opinions which I then advanced, that the rainfall is as abundant as ever, but that countries denuded of their vegetable covering have no means to husband it or regulate its flow. In now again writing on the subject, I have had in view to give a *resumè* of what the Indian Governments have done since it was first under their consideration, to place on record the data that have since accumulated, with deductions therefrom, and to direct future attention to urgent economic points. In now concluding, therefore, it may be confidently stated that in India, within the present century, the rainfall has not diminished, nor has the quantity annually falling now become more uncertain, but that man, partly ignorant and wholly reckless, has denuded the soil of its trees and shrubs and bared the surface to the sun's rays, thus depriving the country of its conservative agents, and making the extremes of floods and droughts of more frequent occurrence and more severe. I have now, however, shown that measures, many of them inexpensive, can be easily adopted, which will early secure a more equable supply of water in the rivers, canals, and

reservoirs, permit cultivation and population to increase, and render scarcity and famines of less frequent occurrence, whilst the bursting of tank bunds, and the destruction of bridges and roads, will be in some measure averted, and lives, and property, and revenue saved.

EDWARD BALFOUR,
Surgeon-General.

2, OXFORD SQUARE, HYDE PARK, LONDON.
20th February 1878.

APPENDIX.

*Remarks of Max von Pettenkofer.**

"Modern hygiene has observed that certain variations in the moisture of the soil have a great influence on the origin and spread of certain epidemic diseases, as, for instance, cholera and typhoid fever; that these diseases do not become epidemic when the moisture in the soil is not above or below a certain level and has remained so for a time. These variations can be measured with greater accuracy by the ground water of the soil than by the rainfall, because in the latter case we have to determine how much water penetrates the ground, how much runs off the surface, and how much evaporates at once. The amount of moisture in the soil of a forest is subject to considerably less variation than that outside. Ebermeyer has deduced the following results from his meteorological observations on forestry: "If from the soil of an open space 100 parts of water evaporate, then from the soil of a forest, free from underwood, 38 parts would evaporate, and from a soil covered with underwood only 15 parts would evaporate." This simple fact explains clearly why the cutting down of wood over tracts of country is always followed by the drying up of wells and springs.

"In India, the home of cholera, much importance has been attached in recent times to plantations as preventives of it. It has always been observed that the villages in wooded districts suffer less than those in treeless plains. Many instances of this are given in the reports by Dr. Bryden, President of the Statistical Office in Calcutta, and Dr. Murray, Inspector

* Max von Pettenkofer, the "Contemporary Review," December 1877, pp. 83—91.

of Hospitals. For instance Bryden compares the district of the Mahanadi,* one of the northern tributaries of the Ganges, the almost treeless district of Rajpoor, with the forest district of Sambalpoor. It is stated that in the villages, in the plain of Rajpoor, 60 or 70 per cent. of the inhabitants are sometimes swept away by cholera in three or four days, while the wooded district of Sambalpoor is often free from it, or it is much less severe. The District Commissioner who had to make a tour in the district on account of the occurrence of cholera reports, amongst other things, as follows: "The road to Sambalpoor runs for sixty or seventy miles through the forest, which round Petorah and Jenkfluss is very dense. Now it is a remarkable fact, nevertheless, that on this route, traversed daily by hundreds of travellers, vehicles, and baggage trains, the cholera rarely appears in this extent of sixty miles, and when it does appear it is in a mild form; but when we come to the road from Arang, westward to Chicholee Bungalow, which runs for about ninety miles through a barren treeless plain, we find the cholera every year in its most severe form, the dead and dying lying by the wayside, and trains of vehicles half of whose conductors are dead."

In the same report Dr. Bryden continues :—

"I will mention one other fact as the result of my observations, namely, that places surrounded by those vast and splendid groves, which are occasionally seen lying in low, and probably marshy situations, surrounded by hills, and which from the mass of decayed vegetation are very subject to fever in September, October, and November, are seldom visited by cholera, and if it occurs there are but few deaths, while places on high ground, or in what are called fine airy situations, free from trees and without hills near, so that they are thoroughly ventilated, suffer very much from cholera."

Murray gives a number of instances showing the influence of trees on the spread of cholera. One of these may find a place here :—

"The fact is generally believed, and not long ago the Medical Officer of Jatisgar, in Central India, offered a striking proof

* "Epidemic Cholera in the Bengal Presidency, 1869," p 225.

of it. During the widespread epidemic of cholera, in Allahabad in 1859, those parts of the garrison, whose barracks had the advantage of having trees near them, enjoyed an indisputable exemption, and precisely in proportion to the thickness and nearness of the shelter. Thus the European cavalry, in the Wellington barracks, which stand between four rows of mango trees, but are yet to a certain extent open, suffered much less than the 4th European regiment, whose quarters were on a high hill, exposed to the full influence of the wind, while the Bengal Horse Artillery, who were in a thicket of mango trees, had but a single case of sickness, and the exemption cannot be regarded as accidental, as the next year the comparative immunity was precisely the same.*

* * * * *

"In the cholera epidemic of 1854, in Bavaria, it was generally observed that the places in the moors were spared, in spite of the otherwise bad condition of the inhabitants. The great plain of the Danube was surrounded by places where it was epidemic, whilst in the plain itself there were but a few scattered cases. The same thing has been demonstrated by Rheinhard, President of the Saxon Medical College. Cholera has visited Saxony eight times since 1836, and every time it spared the northerly district between Pleisse and Spree, where ague is endemic.

"Surface vegetation has also other advantages besides its use in regulating the moisture in the soil; it purifies it from the drainage of human habitations, whereby it is contaminated and impregnated. If this refuse matter remains in soil destitute of growing vegetation, further decomposition sets in, and other processes are induced, not always of a salubrious nature, but often deleterious, the products of which reach us by means of air and water, and may penetrate into our houses.

"We learn from Ebermeyer's work, that the temperature of the trees in a forest, and even in the tops of them, is always lower than the air in the forest.

"The shade of a single tree, therefore, cools, not only by intercepting the sun's rays, but also by the effect of gentle

* "Report on the Treatment of Epidemic Cholera, 1869," p. 4.

fanning. The shelter of a thick wood, however, is much more agreeable than that of a single tree. The air in a wood is cooler than that of an open space exposed to the sun. The air from outside is drawn into the wood, is cooled by it, and cools us again. And it is not only the air that cools us, but the trees themselves. Observations has shown that the trunks of trees in a wood, breast high, even at the hottest time of the day, are 5 per cent. cooler than the air."

Pithecolobium Saman.

Report by G. S. Jenman, Esq., Superintendent of the Botanical Gardens, Castleton, Jamaica, on the Habitat, Growth, &c., of Pithecolobium Saman, Benth. Dated 17th April 1878.

Pithecolobium Saman, or, as it is popularly known in Jamaica, *Guango*, is, as an æsthetic feature, one of the most magnificent subjects in the existing Jamaica Flora. Originally brought over from the American mainland as seed, by Spanish cattle, it has become most thoroughly naturalized in all the dry regions, especially in the Salt Ponds districts, a low-lying part of St. Catherine Parish towards the sea, where it was first established.

It is a lofty tree, with patent tortuous limbs, in general habit and custom much resembling the English oak. The trunk is three to six feet in diameter, generally short, and branched a few feet from the ground. The primary branch divisions are often tree-like in size, measuring nine to twelve feet in circumference at the base. The lower branches spread horizontally, and the upper are erect spreading, giving the tree a flattish dome-shaped appearance. The span of the wide reaching boughs is usually in good specimens over a third greater than the height of the tree. Trees are not infrequent, seventy feet high, the diameter of whose branch expansion horizontally is over one hundred and thirty feet.

The shade which this tree affords is of a light lifesome character, with gleams of sunlight stealing through and flitting about as the branches move with the breeze. This characteristic, with

the fact—which is of equal importance to healthy vegetation—that the leaves and leaflets rigidly close together at night, thus admitting the free descent of dew to the ground together with its squat-like brooding habit, form its first great value as a pasture tree. It is, without doubt, the finest pasture shade tree on the island. Grass grows as freely within the over-shadowing of its ample arms as without, close up to the trunk. In this circumstance alone, it should be planted sufficiently in pastures wherever it will thrive as a grateful shade for cattle. Beyond this is the important consideration of its being a fodder-yielding plant itself, and this hardly in a secondary sense either for the quantity or quality of the yield.

The fruit is a bright dark coloured pod when ripe, six to ten inches long, hardly one inch by a quarter of an inch thick, in substance consisting of a sugary amber-coloured pulp. These pods are borne in great profusion, and hang prior to their maturity, dangling in clusters from every branchlet. As they ripen, they drop to the ground, and are picked up and eaten with much relish by all stock, even sheep and goats. Cattle may be seen lingering about the trees waiting for the passing breeze to shake the fruit down. Its excellent quality as a fodder is evident by its fattening effect. Stock having access to it, improve markedly during the time it is in season.

From the sugary nature of the substance of the fruit, it will keep a good while packed after maturity. It is, therefore, often gathered on the pens, packed in barrels and kept for use till the dry early spring season has parched up grass and made herbage scarce.

There is no doubt, I think, that it would make as good a preserved cattle-food mixed with other ingredients as the "Carob" (*Ceratonia siliqua*), which is largely imported into England from the shores of the Mediterranean for this purpose. *Pithecolobium Saman* thrives best in dry hot plains, having a small or moderate annual rainfall. It is true very large trees are occasionally found in wet districts, but they lack the conspicuously healthful and luxuriant branch development of trees on the plains. They are also very much less fruitful, and the fruit is less plump and mucilaginous in substance. Hot plains,

having an annual rainfall of from 30 to 60 inches, appear best, adapted for its successful growth, either spontaneously or by cultivation. Like many other plants, too, there is no doubt that a maritime influence is particularly favourable to its development.

The utility of this plant as a shade and ornamental tree for open places of resort and wayside has not been mentioned. Its ample spreading habit, the clear refreshing green of the light foliage, the bright cheerful bloom, the quick growth and not least light shade, recommend it as one of the few first-class trees for park and avenue planting. It is unnecessary to point out to residents in tropical countries the value of shade trees along suburban and country roads. In many instances nature has done a great deal to protect tropical roads. The cases are much rarer where man has done anything systematically to supplement her efforts. There are many subjects in the Jamaica Flora well adapted for use in park and avenue planting, but none having a combination of so many valuable qualities as *Pithecolobium Saman*.

Though of a quick growth, the wood is hard and very ornamental in grain.

In concluding this notice, I may mention that the circumstance which has brought the tree into prominence now, of a fine spray-like rain being distilled from the young foliage during the day, sufficient to moisten the ground, has not been observed in Jamaica; but, though it cannot be proved to be more than locally at most a "rain tree," the many and universally permanent good qualities which it possesses, some of which I have mentioned, justify amply its cultivation wherever it will thrive.

Memorandum on the Different Species of Prosopis.

BY J. S. GAMBLE.

Prosopis, a genus of leguminous trees of the sub-order *Mimoseæ*, contains about 18 species dispersed over the tropical and sub-tropical regions of Asia, Africa and America. Of the five sections which compose the genus—sections whose characters are based to some extent upon the shape and structure of the fruit—three may be noticed :—

1. With the pod smooth or slightly thickened at the seeds	Adenopis ...	Contains the two Indian species *P. spicigera*, the well-known 'Jhand,' and *P. Stephaniana* of the Northern Punjab plains and Western Asia.
2. With the pod smooth, thickened at the seeds so as to be almost jointed, and generally falcate ...	Algarobia ...	Contains two of the species now being grown, *viz.*, *P. glandulosa*, of the mountains of Western Texas, and *P. pallida*, of South America
3. With the pod spirally twisted.	Strombocarpa ...	Contains the true 'Mesquit' bean, or *P. pubescens* of Texas and New Mexico.

The 'Jhand' (*P. spicigera*, Linn.) is too well-known to require further notice than is given in the Forest Flora of North-West and Central India.

P. pallida, Kunth., is a native of South America, and has been successfully grown in Ceylon. Its pods are considered of high value as a tanning material, containing, it is said, as much as 90 per cent. of tannic acid. They are known by the name of "Balsamocarpon."

P. glandulosa, Torr., the 'Mesquit or Algaroba of Texas,' is a native of the mountain regions of Western Texas, where it grows into a small tree from 20 to 40 feet high, and with a diameter of 18 inches. It has straight or curved, rather flattened, almost jointed pods, the interior of which is filled with a sweet pulp. The pods, it is believed, are useful for fodder, and are not injurious. It yields an excessively hard and durable timber, with a beautiful grain, and is used for furniture, picket poles, and in the manufacture of charcoal. It also affords a large quantity of gum resembling gum arabic, which exudes from the stem and branches, and has been used as mucilage, in the making of jujubes, and for other purposes.

P. pubescens, Bth., the 'Screw Bean' or 'Screw Mesquit,' is a small tree of Texas, New Mexico and Arizona. It is the 'Tornillo' of the Sonora Mexicans, and is remarkable for its screw-shaped pods. These pods grow in abundant clusters of eight or ten upon the same stem, ripen at all times of the year, and contain much nutritious saccharine matter. The pods have been said to be valuable as fodder for horses; but a recent communication addressed to the Assistant Director of the Royal Gardens at Kew by Mr. R. Thomson, of the Cinchona Plantation, Jamaica, and detailing an experiment he had made which resulted in the death of a horse, shows that great caution is required in their use as fodder for horses. It is suggested, however, that these injurious effects are not noticeable when the beans are given to cattle.

Another species, a native of Jamaica, whose fruits have poisonous properties, is the *P. juliflora*, DC., of the section 'Strombocarpa,' though, for other purposes, the tree appears to be useful for planting in some localities, as the plants when once established go on sending up shoot after shoot, and are difficult to eradicate.

Forest Law in the Eleventh Century.

"THESE are the constitutions of *Canutus* concerning the forest, very barbarously translated out of the Danish tongue into *Latin* by those that took the same in hand. Howbeit as I found it, so I set it down without any alteration of my copy, in any jote or title."

This is the explanation given by Master John Manwood who, somewhere about A.D. 1598, wrote a "Treatise of the Laws of the Forest,"* and who has printed in the book a very

* This book was reprinted, and the third edition of 1665 is what I here make reference to.

curious law called *Charte de Foresta* of King CANUTUS, the Dane, granted at a Parliament holden at Winchester in the year of our Lord 1016. "My Lord, Cook (Coke) bids us beware how we give credit to this," says Master Manwood; but the law is ancient in the extreme and represents early English notions of Forest Law.

These be the rules *(sanctiones)* regarding the forest which I, CANUTUS King, with the advice of my chief men, enact and make, that there may be peace to all Churches of our English Kingdom, and that justice may be done, and that every delinquent may suffer the common lot of delinquents according to the measure of his offence.

1. Let there be henceforth four, of the higher class of men, who have kept all customs intact* (these the English call *Posgened*), in each province of my kingdom, to distribute justice and punishment when deserved, in forest cases, to all my people, Danes as well as English. These four we devise to be the chief men of the Forest.

2. Let each have under him four men of lower class, (whom the English call *Lespegend*, but the Danes, *Yongmen*). These are to bear the charge and care both of vert and venison.†

3. I do not desire that these should have any concern in administering justice: persons of humble condition (mediocres) who have had the care of game may be held to be 'liberales,' whom the Danes call *Ealderman*.

4. Again under each of these let there be two men of the lowest grade whom the English call *Tineman*; these will have the duty of night watch and guard of the vert and venison.‡

5. Should such a man be of servile condition the moment he is placed in our forest let him become free; and we manumit all such at our own expense.

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* "Liberalioribus." As far as I understand the text, it seems higher class of men who have done nothing against their order; nothing to lower them in estimation, &c. These men, says Manwood, are the "Verderers" of a later time.

† These are the "Regarders"—Vert means the forest, the soil and trees; 'Venison,' the game for which the forest existed. A forest according to old English definition, consisted essentially of the (1) Vert, soil and trees; (2) Game; (3) the Forest officers; (4) the Forest Courts.

‡ "These," says Manwood, "are they that now are Foresters or keepers. Here you may note both their office, authority and beginning."

6. Each of the chief men will receive yearly from our stores two horses, one with and one without a saddle, one sword, five lances, one lance-head, a shield and two hundred shillings (*solidi*) of silver.

7. The middle class will get one horse, one lance, one shield and 60 shillings.

8. (Forest officers may be acquitted of certain dues and taxes).

9. Let the causes, both civil and criminal, and of the middle and low classes of officers, be judged and decided by the foreseeing wisdom and reason of the chief men. Grievous crimes (if any there be) of the chief men we ourselves (that no wickedness remain unavenged) will punish in our royal wrath.

10. Let the four (Verderers) have a royal power (save against us in our presence), and four times in the year hold courts (called *Muchehunt*) for all matters touching the forest. Let such matters proceed to the triple judgment, which the English call *Gangfordel*. (This is that five persons with the accused for the sixth can be found all to swear solemnly to accused's innocence.)

The *ordeal by fire* is in no wise to be admitted unless the bare truth cannot otherwise be found out.

11. * * * * * * *

12. * * * * * * *

13. [A person convicted of false testimony is to be held incapable of giving evidence again, and is to pay a fine of 10 shillings.]

14. If any one use force against the chief men, he shall if a free man, lose his liberty and all his possessions; if he be a villain or serf, his right hand shall be cut off.

15. For a second offence death is ordered.

16. If any man contend in a suit against a chief man, he shall forfeit to the King 'his price'* and to the verderer (primarius) 40 shillings.

17. * * * * * * *

* A fixed sum proper to the rank as "liberalis," "mediocris," "minutus," &c.

18. If any man strike a middle class officer (Regarder) he shall pay a fine the same as if he had killed a royal beast of chase.

19. * * * * * * *

20. Penalty and making amend is not to be the same in all cases: there are 'liberales' (whom Danes call Ealderman) and inferiors, masters and servants, known and unknown; nor can the same treatment be applied to all causes, civil or criminal, cases of beasts of the forest and of Royal beasts, of the vert (forest itself) and its game. An offence against the game has been of old, and not undeservedly, classed among greater crimes: but against the "vert" is so insignificant and trifling that our constitution hardly takes notice of it, nevertheless whoever commits an offence in this respect he is to be held guilty of a forest crime.

21. If a freeman (*liberalis*) chases, even by accident, any beasts of the forest, so as to make him pant with hard running, he shall pay 10 shillings to the king; if an inferior (*illiberalis*) he shall pay double; if a serf, he shall lose his skin (*careat corio.*)

22. (If the animal is killed, double penalty.)

23. If either of the above classes has driven and caused to pant a Royal beast which the English call a *Staggon*, one shall be imprisoned for a year, the other for two years, and if a serf, he shall be an outlaw, whom the English call *Frendlesman*.

24. If the stag be killed, a freeman shall lose the scutcheon of his liberty; if not a freeman, he shall, (*careat libertate*—whatever that may be, perhaps 'be reduced to the condition of a serf); if he is a slave he loses his life.

25. Bishops, Abbots and Barons may hunt, but not Royal beasts, [if they kill Royal beasts they are to pay amends to the king at his pleasure.]

26. (Some animals, as wild goats, hares and conies (*cuniculi*) are protected as long as they are in the forest itself. Others as wild horses, *Bubali* (?), kine, and the like, live under the shelter of the forest, but are not beasts of the forest properly so called; and foxes and wolves are not forest beasts in any sense.)

27. No one shall lay his hand on either the wood or the underwood; if any one does so, he is guilty of breaking the Royal chase.

28. If he cut down a holly tree, or any tree which supplies food to the game, besides the penalty for breaking the chase-royal, he shall pay a fine of 20 shillings.

29. I will, that every freeman take his vert and venery on his own lands and respect mine.

30. No middle class man or mean person may keep the dogs which the English call *Greyhounds*. Freemen may keep them if they have the knee sinew cut before the Verderer, &c.

31. Dogs called *velter*, also those called *Ramhundt*, may be kept, as they do not imperil the game.

32. * * * * * * *

33. If a mad dog bite any beast of the chase, his owner, if a freeman, shall pay a fine according to the price of a freeman, which is twelve hundred shillings. If he bite a Royal beast the owner is guilty of the greatest crime.

B. H. B.-P.

Extracts from the Report of the Royal Botanical Garden, Calcutta, for the year 1877-78.

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5. *India-rubber.*—The seedlings of Para rubber received in the beginning of 1877 were partly retained in this garden and partly sent to the Cinchona plantation in Sikkim. Several of these plants have died during the year. The plants that still remain here (14 in number) are, however, healthy, and have grown fairly well. Every care is being taken of them, and I hope soon to be able to report that they have been increased in number by artificial propagation; but former experience has made me wary of allowing cuttings to be made until the parent plants have had plenty of time thoroughly to establish themselves. A quantity of Ceara rubber plants, collected in South America by Mr. Cross, and sent to this garden by Sir Joseph Hooker, were received along with the Para rubbers. About one-third of the plants in this consignment were found on

arrival to be in bad condition or dead. Of the remainder, five were sent to the Cinchona plantation, and the balance were retained here. One of the plants here is now ten feet high, and the others vary in height from two to five feet; but they all look more or less weak and lanky, as if the climate were too damp for them. This plant (a species of *Manihot*) was found by Mr. Cross in quite a different kind of country from the Para rubber, and it appears more likely to succeed in India than the latter. My object, both with the Para and Ceara rubbers, will be to propagate as large a stock of young plants of each as possible, to find out spots with climate suitable for each, and to have small plantations made wherever efficient supervision can be secured in such places.

6. *Vanilla.*—Further experience has only strengthened my conviction that *vanilla* cannot be grown as a crop in the climate of Calcutta with any prospect of success. I observe that even in Bangalore, where for a time it was supposed to have promised well, a similar conclusion has lately been arrived at. The plants now in the garden will, of course, be attended to; but I do not think it is worth while to go to any further expense in attempting to make a plantation of it to be conducted on commercial principles.

7. *Ipecacuanha.*—A number of plants of ipecacuanha have been sent to the Botanical Garden at Singapore, which enjoys a climate that ought to suit ipecacuanha perfectly. A considerable stock of young plants is kept on hand at the Cinchona plantation ready for issue to any applicant. But, like *vanilla*, I fear this valuable drug can never be grown successfully as a crop in any part of Bengal. We have been perfectly successful in propagating the plant from root, cuttings and seed, and it grows luxuriantly under cover. But out-of-doors the low night temperature of the cold weather proves too severe for it. During the year, 26 pounds of the dried root, taken from plants grown in frames under Mr. Jaffrey's care at Rungbee, were sent to the medical depôt for use, previous trials having established the excellence of the Sikkim-grown drug.

8. *Rheea.*—The Government of India having decided again to offer a prize for the invention of a machine to clean rheea

fibre, a couple of acres of ground were put under this plant in order that intending competitors might be supplied with green stems to work with. The ground having been trenched and manured, the crop offers to be a good one; but rheea does not appear to me to grow with such luxuriance here as in the drier climate of Saharanpur, where the competition for the Government prize is to be conducted.

9. *Baobab, Bamboo, and other Paper Fibres.*—The curious baobab tree is a native of Africa, but appears for a long time to have been a favourite with Mussulmans in India. Large trees of it are found planted near Calcutta, Patna, Agra, and at many other places in India. Baobab bark began some years ago to be largely imported into London from the Portuguese settlements in Africa, and proved an excellent paper fibre. At the suggestion of Sir Joseph Hooker, I made three years ago a small plantation of it with the view of testing the possibility of growing *it sufficiently cheaply to be used as a paper fibre.* For the past two years the plants put out here received a rough kind of cultivation, and the grass between them was regularly cut; but, as this could hardly be afforded in a plantation conducted on commercial principles, I did not think it fair to the experiment to continue even the little cultivation which the plants had hitherto received. During the past year, the young baobabs have, therefore, had to fight their own battle, and it is quite clear that the majority of them are going to be mastered by the coarse, deep-rooting grasses which infest the soil everywhere in the plains of Bengal. Such plants as enjoy the shade of a large tree in the neighbourhood of the plantation continue to look very fairly healthy, but those that stand in the open look very sickly. If baobab were to be grown to a profit, it would be hardly feasible to give it cultivation, however rough, after the first year, and it might not always be possible to give it shade. Considering, moreover, the comparatively slow growth of the species (a tree of 20 years old grown in the open girths, about 3½ feet at the base and is about 15 feet high), I am driven to the conclusion that baobab is not likely to afford in India a sufficiently cheap paper fibre. My own impression is, that a plant yielding an annual crop is more likely to fulfil the finan-

cial conditions of success than any perennial which, like baobab, yields a crop only after many years. Acting on this conviction, I sent to the India Office samples of four common Indian plants, and suggested that their value as paper fibres should be ascertained. The samples consisted of the stem and leaves of (1) the *bhabar-ghas* (*Eriophorum comosum*) of the North-West Provinces, which is so largely used as a material for ropes in Upper India; (2) of *Saccharum spontaneum*, a tall, coarse grass which, under the name of *kash*, is only too abundant in waste places over a large part of India; (3) of *Imperata cylindrica*, the well-known *ooloo*, the commonest grass in Lower Bengal; and (4) of *Typha elephantina*, the *hogla* of Bengalis, a large bulrush abundant all over Lower Bengal in marshy places and by the sides of tanks and streams. *Eriophorum*, not growing naturally in Lower Bengal, would reach a seaport weighted by the cost of long carriage, and may therefore practically be excluded from competition in the export market; but the other three are common plants all over the Gangetic delta, and could be brought to Calcutta in any quantity and at very low rates. The four samples were reported on by Mr. Routledge, of the Ford Paper Works, near Sunderland, who has devoted so much attention to the utilization of the young shoots of bamboo as a paper fibre. Mr. Routledge states that "all four will unquestionably make paper." "*Eriophorum* is," he says, "the best and most easily-worked of the four, as a small quantity of bleach brings it into good order." "The ultimate fibre is," he continues, "very fine and delicate, rather more so than *esparto*, and of about the same strength. The yield (42 per cent.) is somewhat less, I think." Mr. Routledge goes on to say, "it will make a quality of paper equal to *esparto*. "The remainder of Mr. Routledge's report is not very encouraging, but I give it *verbatim*, for I know that the increasing deficiency in the supply, and consequent rise in price of materials suitable for paper-making, have been exciting a good deal of interest for some time, and under such circumstances the records of failures, entire or partial, are nearly as useful as the records of success.

"The grass marked *Saccharum spontaneum* ranks next to

Eriophorum in quality; it is more tender, and certainly not equal to *esparto*; it yields 44 per cent. of fibre.

"The grass *Imperata cylindrica* I do not think suitable for paper, certainly not for printing, although it may suit for what are termed small hands and rough packing papers. It is full of small joints and knots (especially the lower portions of the stalk), which result in harsh woody sheaves. It gives an yield of 41 per cent.

"The *Typha latifolia* gives a very strong fibre when purged of the glutinous compounds living in its cellular tissue; but in consequence of this mass of gluten, the yield is very small (only 28 per cent.); it is also extremely difficult to bleach, and loses most of its strength when subjected to that process.

"I do not consider that it would pay commercially to attempt to treat any one of these fibrous materials for conversion into 'stock' for European use, although very possibly, if procurable in abundance and at cheap rates, they might be employed for paper-making, locally, with advantage.

"To come into this (the home) market, any material must be superior to *esparto* in quality, as no matter how cheap the raw material may be in India, the cost and charges for converting it into stock and transport to Europe will bring its price to afford any profit to the producer as high or nearly as high as *esparto*.

"The importer, therefore, must be prepared to sell his stock as cheap, or nearly as cheap, as *esparto*, reduced to the same condition of stock, and must also give the inducement of superiority of quality."

In the Resolution on my last annual report it was suggested that I should get from the Orissa and Chittagong coasts specimens of the wiry grasses growing on the beach. This has been done, but no report on the samples has yet been got. I propose to continue to give attention to this subject of paper fibre, and hope to note the results in future reports.

It will be remembered that several years ago, Mr. Routledge, an English paper-maker, drew the attention of Government to the value as a paper material of the fibre yielded by the immature shoots of bamboo. Healthy bamboo clumps, as everybody

in India knows, send up during every rainy season a certain number of new shoots which, growing with enormous rapidity, in a few weeks attain their full height, and afterwards slowly harden and develop leaves. Mr. Routledge expressed his belief that by a simple treatment in this country a "stock" might be extracted from these shoots which might be profitably transmitted to England for manufacture into paper. During the past two or three years, I have put Mr. Routledge's proposals about coppicing bamboo to a practical test, and in my last report I recorded my observations so far as they had gone. I shall now bring them up to date; but before doing so it may be convenient to reproduce what I wrote last year. I therefore quote from my last report:—

"It is essential to the success of Mr. Routledge's process that the bamboo shoots be quite young and succulent, and the great difficulty which at once presented itself to persons with any knowledge of the mode of growth of Indian bamboos was that such shoots, being produced in moderate quantity from each clump, and only during a limited season of the year, the proposed paper-stock-making machinery must, for a large part of the year, necessarily lie idle. To meet this difficulty, Mr. Routledge suggested that bamboo clumps might, by proper treatment, be induced, after most of their old shoots had been cut away, to send up from the stools thus bared, regularly and irrespective of season, crops of succulent shoots suitable for conversion into paper-stock. Mr. Routledge's expectations imply a very complete change of habit in the bamboo; for it is pretty well known that bamboo clumps, if entirely cut down, yield for several years but few and small succulent shoots, and, in fact, not unfrequently die. In order, however, to submit the proposed scheme to a trial under my own eye, six clumps of *Bambusa Baleeoa* were cut down last year, *i.e.*, in 1876, at the beginning of the rains, between 10th and 20th June, when the buds of the young shoots of the season had completely formed and were nearly ready to burst through the soil. Soon after the cutting of the old stems, these buds developed into shoots which grew with characteristic rapidity. These were allowed to grow until they began to show symptoms

of becoming hard, and on 21st July they were all cut down. They were at once weighed with the following result:—

	Number of young shoots.	Weight in pounds.
Clump No. 1 ...	11	166
Ditto 2 ...	7	102
Ditto 3 ...	6	78
Ditto 4 ...	9	100
Ditto 5 ...	5	42
Ditto 6 ...	12	192
Total ...	50	680

This gives an average of 113 pounds of wet young shoots per clump. The time of cutting was the most favourable that could have been chosen, and the crop of shoots yielded was probably as good as it would have been had the clumps remained untouched by the knife. Judging from the size of the clumps I calculate that at most 80 similar clumps could be grown on an acre of ground. This allows an area of 576 superficial feet to each clump, and such close planting would probably necessitate manuring. Taking the yield of these six clumps as an average, and excluding all loss from death and accident, the yield on an acre during the first year of cutting would therefore be 9,066 pounds of fresh young shoots. It must not be forgotten that freshly-cut bamboo shoots are extremely succulent, and that the amount of dry paper-stock that could be got from them would bear a very small proportion to their original weight. An additional difficulty that attends the scheme is that, since only fresh succulent shoots will answer, and these are of too high specific gravity to float, the cost of land carriage to the factory (a very heavy one in Bengal) would have to be incurred. The cut clumps above-mentioned were well cared for; leaf mould and tank soil were laid round them; and, as compared to similar clumps in the forest, they had the great advantage of immunity from fire and from being grazed on by cattle. Since their young shoots were cut, a consider-

able number of thin woody twigs have arisen from the bases of the old stems. No fresh young root shoots have, however, appeared. Some such will doubtless appear at the usual time, which would be the beginning of the ensuing rainy season. These shoots shall be cut at the time recommended by Mr. Routledge, *i.e.*, when they are just beginning to become hard and woody, and with the cutting of these the crucial part of the experiment will begin. The results shall be duly recorded in next annual report."

In the beginning of the rainy season of last year, the brushwood of thin woody twigs, which had been produced by each clump, was cut off, but amongst the twigs there were none of the soft, succulent shoots proceeding from the underground stem which are required for Mr. Routledge's process. The early rain of the present season was particularly favourable to the production of young shoots, and the clumps have just again (10th July 1878) been cleared of every twig produced by them since the previous cutting. The result is that, just as last year, the most of the growth consists of hard woody twigs which proceed from the bases of the stems cut two years ago. There are only a few of the succulent shoots proceeding from underground, and the total yield of materials succulent enough for Mr. Routledge's process, is 120 pounds, or an average of 20 pounds of green material per clump. In a pamphlet published on the subject, Mr. Routledge estimates that the green raw material dries to one-fourth of its weight, and that the dry material gives 60 per cent. of good paper-stock. I am, therefore, in a position to give the yield of paper-stock of these six clumps during three years. The yield during the first year was about 17 pounds per clump, equal (allowing 80 clumps to the acre) to about 1,360 pounds per acre. During the second year, the yield was nothing, and during the third year it was 3 pounds per clump, or equal 240 pounds per acre. Mr. Routledge estimates that (according to a method of planting which he proposes, but which I believe to be quite impracticable) the yield per acre would be 6 tons, *and that this yield would be annual.* The value of the paper-stock delivered in England would be from £20 to £25 per ton, so that, even

assuming (which is by no means the case) that green bamboos are of very little value, the proposed new industry does not present a hopeful financial aspect.

10. *Carob and other economic trees.*—A smaller quantity of the seed of the carob of the Mediterranean (the *Ceratonia siliqua* of botanists) was sent some time ago to the garden to be sown, with the view of introducing this tree into Bengal. The pod of this species, as Government are aware, contains a sweet nutritious pulp, which forms an excellent food for cattle and horses. But the tree does not naturally affect a climate and soil in the least like those of the Gangetic delta, and I never looked on the attempt to add it to the fodder plants of Bengal as at all likely to succeed ; and, as a fact, the majority of the seedlings damped off before they were six inches high. About 50 seedlings remain, some of which have been planted out, while the others, which are too small for planting out, remain in pots. But although all have been duly cared for, none are vigorous. An American tree, which also yields a sweet nutritious pod, has been much more successful than the carob. This is the *Pithecolobium Saman*, a native of Peru which, from its supposed property of inducing local showers, is in that country known as the "rain-tree." An exact description and explanation of the phenomenon which gave rise to this name has only quite recently been given in the columns of the English periodical, *Nature*, by Dr. Dyer, who quotes from the eminent South American traveller, Mr. Spruce, as follows :* "A little after seven o'clock, we came under a lowish spreading tree, from which, with a perfectly clear sky overhead, a smart rain was falling. A glance upwards showed a multitude of cicadas sucking the juices of the tender young branches and leaves, and squirting forth slender streams of limpid fluid. We had barely time to note this when we were assailed by swarms of large black ants, which bit and stung fiercely and obliged us to beat a retreat, my companions calling out as they ran '*tamia-caspi ! tamia caspi !*' When we had shaken off our assailants, I ventured to approach the spot so near as

* For Dr. Dyer's note, see Article entitled "The Rain-tree of Moyobamba" at page 313 of the April Number of the *Indian Forester*, 1878.—ED.

to make out that the ants were greedily licking up the fluid as it fell." There are in the garden two sets of this tree: one consisting of five trees about eleven years old, and the other consisting of 84 trees which were planted in an avenue four years ago. The tree is an extremely rapid grower, and seems perfectly at home in the climate and soil of Lower Bengal. It has a thick trunk, which, at a comparatively short distance from the grounds, divides into large branches, which form a spreading and very dense crown. This habit, together with the softness of the timber, make the tree of little value as a source of material for building, but it would probably answer very well as a firewood tree, and as a shade tree I know nothing to equal it in Bengal. It grows faster than any indigenous tree known to me, and the only introduced tree which rivals it is the *Casuarina equisetifolia*. The five older trees in this garden girth on an average seven feet nine inches at three feet from the ground; while of the four-year old trees, which are planted 32 feet apart, as an avenue on either side of a road 20 feet wide, the heads now meet across the road and afford an excellent shade. The average height of these younger trees is about 20 feet, and the average girth of their stems at three feet from the ground is 29 inches. The older trees have this year, for the first time, given seed; the pod is quite as sweet as that of the carob, and is abundantly produced, and altogether I consider *Pithecolobium Saman* a much more hopeful source of cattle fodder than the carob, while, as a rapid grower, it is unrivalled. Quantities of seeds of various species of *Eucalyptus* were sent by the Government of India during the year for trial in the garden. Of these a considerable proportion failed to germinate, and of those which did germinate the majority of the seedlings damped off during the rainy season, and at the end of the year only three plants remained alive. This result is quite in accordance with former experience, which goes to show that the project of ameliorating the malarious climate of Lower Bengal by the free planting of *Eucalyptus* is perfectly utopian. The water-logged alluvial soil and hot steamy climate of this part of India are totally unsuited to any species of these Australian trees which has yet been tried. Moreover,

it seems highly doubtful whether, even where it grows vigorously, the *Eucalyptus* has any especial effect on malaria. I understand that many species of *Eucalyptus* grow well at Shillong and at several of the stations on the North-Western Himalaya—a fact which in itself offers a strong argument against the probability of their success in a climate so totally different as is that of Calcutta.

On Methods of cutting to secure Natural Reproduction in Pine Forests on steep slopes.

I.—General.

High forest on gentle slopes, or on the level up to a certain elevation, can always be treated by the ordinary method (called "regular") of successive cuttings disposed so as to allow of "natural reproduction followed by thinnings."

But as we ascend beyond a certain elevation, natural reproduction becomes more difficult; and then as the slopes become steeper, it is found that a succession of three or four cuttings produces but a meagre result, if any at all. Moreover, the damage done by felling the old trees on a steep slope is very great; unless every tree of the second and final cuttings were to be found exactly on the edge of a timber road.

Therefore it is commonly given as a general rule, that above a certain elevation and on steep slopes, pine forests are exploited by the 'selection' method.

But where is the point at which we must put aside the regular method and commence that of selection? It is often difficult to define. Besides this, the selection method has its disadvantages. If the cuttings are repeated in too rapid succession over the forest area the reproduction will be slow and insufficient: if they are made too gradually, there will be a deterioration of the produce, the trees being too old and beginning to decay, or else not having had sufficient room to attain their full development.

In cases, then, where the application of the regular method may be doubtful, and where it is not certain that selection cutting is absolutely necessary, we offer a method which

is between the two. It is applicable to pine forests, whether pure or mixed (*in moderate proportion*) with *deciduous species*.

In theory, a perfect "*jardinage*" would be one that every year selected a number of trees over the whole area of the forest. Practically, a forest cannot conveniently be treated on this system of felling otherwise than by arranging that the whole extent shall be cut over once in ten, fifteen, or twenty years. And even then it is a matter of great difficulty in a rocky and precipitous country, where felling (and indeed moving about) is fraught with danger, to be sure that the forest has been really equably treated, [*i. e.*, not cut over too much in one part, leaving the least accessible places alone.]

If it has not been equably cut over, there will of course be compartments where nothing but old trees remain, *and no gradation of ages* coming on to maturity.

The following case was what led to the adoption of the method recommended :—

There was a forest of *A. pectinata* (Silver fir) very open, and composed of trees aged from 1 to 60, and from 91 to 120 years, each filling a considerable area; but trees between 61 and 90 years were entirely wanting. The two classes named were found in complete mixture, and each occupied about half the total area.

It happened that I had to make an extraordinary cutting for the relief of the inhabitants of a hamlet which had been entirely consumed by fire. At first my intention was to cut out of the class, aged from 91 to 120 years, those which appeared to have passed the age of 105 or 110 years, and consequently to reserve (as not yet mature and also to shed seed) all those between 91 and 105 or 110 years. The parties interested, however, implored me to cut some of these as well as the former, because they were easier to cut and less expensive to utilize.

The site for the felling was about 1,600 metres above the sea level (about 5,500 feet) on a steep slope somewhat difficult of access. It was probable that we should not retain them or make another cutting, and I began to ask myself why trees, aged 30 to 40 or 60 years, should not suffice to effect the

re-stocking by their seedfall, as well as older trees. After serious reflection, I thought I might safely comply with the request made, and I marked for felling all the trees aged from 91 to 120 years.

I am able to state that the felling did very little damage to the young trees (*i. e.*, those from 1 to 60 years which alone remained), and some years after I found that *these* had sufficed to effect a complete re-production of seedlings.

Since then I have not hesitated to trust to the trees not yet arrived at half the age of exploitability, rather than to trees already past that age. I have had no reason ever to repent of this. Such is the origin and such the *rationale* of the method I propose.

II.—Re-generation by a Single Cutting.

Let us then assume that we have a pure or mixed forest of pines, subject to 'selection felling,' and exploitable at the age of 120 years.

Let us then divide the forest into sixty "*coupes*," which will be worked successively from one to the other for sixty years, and then for sixty years over again, in such a manner that after a certain time we shall only have two ages on each. No. 60 will have ages one and sixty-one. No. 59 will have two and sixty-two. No. 2 will have fifty-nine and one hundred and nineteen, and No. 1, sixty and one hundred and twenty.

Without entering into detail as to the cuttings, it is easy to understand that it will suffice, in order to obtain the desired result, to subject the high forest to a revolution of 120 years,* divided into two periods of sixty years, during each of which the whole forest will be cut over. Only trees over sixty years old will be cut in each year's felling, and *all* these will come down, leaving all the rest.

There is nothing which in principle renders it impossible, that each *coupe* should gradually be brought into this state by

* Practically, the revolution and the periods will be a little longer, on account of the necessity of awaiting the seed years, or actual time of the springing up of seedlings.

having each one-half of its extent occupied by each of the two ages, (1 and 61, 2 and 62, 3 and 63, 59 and 119, 60 and 120) trying to get these two ages in as even a mixture as possible over the whole. Practically, this will not be done at first; it will require time, care, and some slight departures from regular practice.

Once in the desired state, and ever afterwards, the exploitation will only be of trees aged 120 years, and the regeneration will be entrusted to the trees aged 60 years, which will be scattered about in groups two, three, or four together, but in sum-total covering as nearly as possible one-half of the ground.

Such a covering (*peuplement*) will be very open; but let us recollect that trees of 60 years are more sturdy and well-rooted and better able to resist storms than the oldest trees, and that the trees being in groups of two to four their solidity is greater.

The danger will gradually become less and less, as the young growth between gets higher and higher.

Such is, in a few words, our system of re-generation (in selection forests) by a single cutting.

An *ideal selection* would be to take out of the *whole forest, every year, every tree that had reached the fixed age of exploitability*, and the ideal forests for this treatment would consist of all ages suitably intermingled in suitable proportions.

In a perfect high forest on the "natural" method, all the trees of the same age must be grouped on as many different compartments as there are distinct ages, and there would be as many compartments each of its own age as there are years in the period of rotation.

In a regular high forest on the 'natural' method, the old trees disappear according to convenience of cutting, as soon as the regeneration is assured.

In this method, the trees effecting the regeneration being only 60 years old (and not being exploitable till 120) *survive* the young crop, and thus secure, the ultimate success of the regeneration *on steep slopes* [where one or more successions of young growth may fail: and would not be replaceable naturally if the old trees were all gone at time of failure.]

The plan advocated may be called the "mixed method," as it shows something between the regular march of revolution in the "natural" method, and the absence of any revolution at all in a normal 'selection' method.

In actual practice, all *improvement* cuttings or thinnings, after the *yield* cutting has been made, must be so arranged that the reserved trees for shedding seed should be in groups of two, three or four. In each "bouquet," circumstances must determine the distance of the trees, but for a standard, it may be said that the best form would be a triangle whose sides were 6 feet long, and a tree at each point.

III.—Objections and Conclusion.

No objection can really be raised theoretically to our proposal.

In practice, however, there may be difficulties in the way of its application. These may, however, be overcome by resolution and good sense. Once be firmly convinced that the thing is right in principle, and it can be carried out in spite of difficulties. Nor is there anything which renders the plan unyielding. It can be modified according to special circumstances of soil and situation, as may be seen from an example.

If, for instance, great inequality of the soil or some other cause should render it impossible, either on one "*coupe*" or on all or part of the "*coupes*" of a series, to secure an uniform distribution of two age classes, that is to say, a perfect admixture of the two ages over the whole extent of the *coupe* or *coupes*, there would be nothing to hinder a complete separation of two such classes. In that case, the *coupes* might require to be made long and narrow, and such class might occupy the whole length and one-half the breadth. And this will be seen to be nothing else but the first method, indicated for working a high forest of Spruce, (note Parade's *Culture des Bois*, Book III, Chapter II, Article 12) with this important difference, that the re-stocking by seed according to our method being effected by strips of 60 years age, there is no need to consider when these strips should be cut, as their turn will of necessity and by rule come at a fixed date, that is to say, at the end of another 60 years.

In all cases an absolute rule is rarely possible. We have always to enquire, first: Is selection felling absolutely needed at all? And next: if the forest is such that this method can be applied at all? If it is, the method will not be found really difficult to apply.

To sum up the whole principle in a few words:

Regeneration will be effected as well, if not better, by reserved trees of an average age of half that of maturity (*viz.*, the latter being 120 years—by trees on an average of 60 years). And this regeneration may be effected by *a single cutting*: and the method is applicable especially to steep slopes of high mountain ranges.—(*Translated from the French of M. Regimbeau*, "*Revue des Eaux, &c.*," February 1878.)

B. H. BADEN-POWELL.

The function of the Pines and the Larch in the production of soil.

(*Translated from the French of M. Charles Broillard in the "Révue des Deux Mondes" for April* 1877.)

The Pines, as we are accustomed to call the long-needled section of the Coniferæ, have each their proper and fit locality. They are not found in fertile plains, but rather occupy the poorest soils, and each separate species seems to have made it its special mission to render fertile some kind of barren land, whether shifting dune, arid sand, sandstone, compact limestone, burnt-up schist, or naked granite: and there is scarcely, so to speak, between the tropics and the polar circle, a single description of rock on which the pines have not succeeded in establishing themselves. They fix and improve the sands of the dunes, break up the sandstones, pulverise the limestones and the schists, decompose the granites and transform the mineral into vegetable soil. And, first of all, they cover the ground with a thick carpet of dead needles, which keeps up its freshness and collects and stores the rain. Next, with their roots both tracing and penetrating, they take possession of the rock itself. Their winged seeds, carried everywhere by the wind,

spread themselves to great distances and found new colonies on arid soils far from the parent tree. And in time the uninterrupted sheet of pine forest spreads itself over immense surfaces, exercising a powerful action on the climate whose extremes it does its best to modify.

And now that once the pines have prepared the way, under their light cover come other kinds of tree—the oak and the fir, and one by one the other trees of the forest continuing and completing the work of re-fertilization.

The larch also in certain cold regions acts a somewhat analogous pioneering part, but it is in the fresh soils which have already a fertility of their own, and which it transforms into meadow forests, bringing them to a degree of fertility greater than that done by the pine woods. The part of the larch in the production of soil is then higher and more important than that of the pines.

In former ages these species were far more extensively found than they are at present. Traces of them are found in the coal fields; and old peat mosses in the plains of Central Europe, where their place is now taken by broad-leaved trees, often yield the debris of existing species. In Europe, the resinous trees with light canopy, are chiefly now to be found in the north and in the south of the Continent; and it is there, as well as in mountainous regions, that they occur to be the most useful in restoring the soil; but still, everywhere there may be found localities, such as sterile plains or rocky slopes, on which their powers of re-fertilization might well be tried. Without leaving France, it will be sufficient to mention the Landes and Dunes of Gascony, the mountains of the Maures and Esterel, the plains of Sologne and Champagne, the sands in the vicinity of Paris, the dry denuded tracts on the hills of Burgundy, the high plateaux of Auvergne, and the abrupt slopes of the Alps and Pyrenees: to show how important is the fact that can be played by the pines in the general economy of the regions of the temperate zone.

The chief characteristics which distinguish the pines from the firs are: their long and fascicled leaves, their fruits which require two or three years for ripening, and their leaf-buds which

appear only at the ends of the branches; and it is in consequence of this latter characteristic that the form of their stem is generally so regular, though in some special cases the stem is bent and presents an irregular and not very graceful appearance. It is then only the old trees which show that character of strength and majesty which makes their true beauty. The genus pine, though in the Northern Hemisphere represented by numerous species, does not occur in the Southern; as the trees habitually mentioned as pines in the latter are not in reality of the same genus. Those of the 'Isle of Pines' and of 'New Caledonia,' are really column-like *Araucarias* and broad fleshy-leaved *Dammaras*. The Southern limit of cone-bearing trees is, in fact, with one exception, *viz.*, the high plateaux of Mexico, the Tropic of Cancer. The European pines have two leaves, that is, they have each two needles in each leaf-sheath. There is, however, one exception; for the *Cembro* has five leaves like the Weymouth pine which comes from the region of the great North American lakes and the valley of the St. Lawrence, like the *Pinus excelsa* (justly called in the Himalaya the king of pines) and like many other species of Mexico and California. The three-leaved pines, though not found in Europe, are very common in America. Among the most important are the magnificent *Pinus Sabiniana*, an inhabitant of the Rocky Mountains; the *Pinus australensis*, which covers the Landes of the Southern North American States, and produces the Boston turpentine; the *Pinus canariensis*, a valuable species, almost now extinct; and last of all the *Pinus longifolia*, which forms such immense forests near the source of the Ganges. The two-leaved pines seem, with a few exceptions, like the red pine of Canada, a species resembling the *Pinus laricio* of Corsica, to be confined to the old world.

In the varied climates of the different regions of France—climates varying between that of the olive and that of the rhododendron—all the European species of the genus *Pinus* are found, *viz.*, *Pinea halepensis, maritima, Laricio, sylvestris, montana and Cembro*; and these species are, according to climate, naturally enough divided into two sections, the first

four occupying the south, and last three being found in the north of France.

The *Pinus Pinea*, the stone or Italian pine, is found here and there along the Mediterranean Coast. Being an inhabitant of low hot plains it is rare in France, nevertheless in the Silveréal Pinetum in the Camargue, an old forest interspersed with marshes and lakes and now almost destroyed, it is found mixed with the Aleppo pine; the stone pine, however, though the dominant species, has in that locality only trunks of about 4 metres in height.

The Great Pinetum, which covers the dunes of the Adriatic to the south of Ravenna, is composed of stone pine, and formerly fine trees were to be seen in the forest. It may also be seen in some forests of the province of Oran in Algeria, where its tall stem, rising high above the other species, spreads over them its broad crown. In fact, the stone pine sometimes forms a fine tree of 30 metres in height, carrying aloft above a splendid trunk, a corymbosely-branched crown which, with its leaves always outside, bears no inconsiderable resemblance to a gigantic parasol. Its rich green leaves, tinged slightly with blue, match well with the rusty colour of the stem and branches, and standing out sharp and clear in the blue Italian sky, the stone pine forms a remarkable object in the landscape. As its growth is less vigorous in France it is usually planted only as a fruit tree in the gardens of Provence and Languedoc. The fruit is a large rounded cone, enclosing long seeds, with a very hard shell and an edible kernel, which has the flavour of the hazelnut and is used in confectionery.

It requires three years to ripen its fruits, while other pines only require two. Some other species of pine, such as the *Pinus Sabiniana*, *Fremontiana*, and others have edible seeds; some indeed have very large nuts, which are a great food resource for the Indians; but in Europe, of edible pines we have only the *Pinus Pinea* of the sunny plains of Italy and the *Pinus Cembro* of the Alpine summits. The seeds of all the edible pines have a slightly resinous flavour.

The *Pinus halepensis*, or Aleppo Pine, is rarely found at any distance from the shores of the Mediterranean, and even in these

shores only in limestone soils. Consequently forests of it are only found in certain localities, and those often very distant from each other. It is said to have first come from Syria, and it is consequently also known under the name of the 'Jerusalem Pine,' while in Provence it is called the 'white pine': in fact, its silvery bark and light-colored foliage easily distinguish it from others.

Its home is an arid land and sun-scorched rocks, and with the evergreen oak it gives, so to speak, life to the desert. It does not form thick masses of forest, but is generally found in the condition of single separate trees, which give scarcely any shade to the ground, while under them comes up an undergrowth which is chiefly composed of shrubs peculiar to the Mediterranean Coast, such as the kermes oak, myrtle, arbutus and azalea—water, however, and the fresh and tender grasses of the northern pine forests are always wanting.

The short slightly-drooping needles of the *Pinus halepensis* give it an elegant foliage; and if it grew tall and straight with a spreading top, it would be a very handsome tree; it however has generally only a moderate height, a twisting stem, and reaches only small dimensions. There are several thousand hectares of it in the Department of the Bouches du Rhône, chiefly between Toulon and Marseilles; and it there forms the Communal Forests of Cassis and La Ciotat; the forest of Gémenos, which clothes the slopes of the mountains at the entrance of the charming valley of St. Pons; and the great pine-woods through which the road from Marseilles to Toulon passes. The prettiest forest of this species is perhaps that which covers the small island of St. Marguerite near Cannes, which seems more like a corner of Africa cut off and transported to France. The Aleppo pine is also one of the important forest trees of the province of Oran in Algeria, of Andalusia, Southern Italy, Greece, and, above all, of the low hills of European and Asiatic Turkey.

It is the *Pinus maritima*, or Pinaster, which forms the forests of the Landes of Gascony. This vast pinetum now extends uninterruptedly from Bordeaux to Bayonne, and hence the common names of 'Bordeaux' and 'Landes Pine' have been

given to the tree of which it is almost exclusively formed. It is less delicate than the Aleppo pine, the denizen of the land of the olive; and it not only covers the sandy hills of the Gascon 'dunes,' but rises on the hills (for instance in Corsica) even up to 1,000 metres in altitude.

The opposite of the Aleppo pine, the Pinaster, is never found on limestone, but it requires for its favorable growth a silicious formation, such as sand, granite or gneiss. Thus the sandstone formation of the mountains of the Maures between Draguiguan, Fréjus and Toulon are covered with Pinaster and Cork-oak, while the limestones around are occupied by the Aleppo pine and the ilex, a good example of the way in which natural laws determine for each species its proper place and soil. In suitable places and at a suitable altitude, the Pinaster may be found on the whole of the coast region of Southern Europe from the mouth of the Loire to that of the Danube. It does not seem able to live far from the sea; there are forests of it in the islands of the Mediterranean and in Algeria, but its most favorable position is on the coast of the Atlantic, in Portugal, as well as in Gascony. There are now in France about 700,000 hectares of forest of this pine, and out of this amount nearly 600,000 are to be found in the triangle formed by the rivers Garonne and Adour; the rest being from north of the Garonne, Provence, Corsica and Algeria.

The *Pinus maritima* is not a beautiful tree; its few, long, coarse-looking, yellowish-green needles give only a poor foliage; its bark is blackish, and its stem short; and from the light and uniform appearance of the forests one would scarcely, at first sight, believe in the activity of the vegetation and the wealth they conceal.

The long wounds formed in the extraction of the resin, and the little cups hanging to the trees to receive it, complete the monotonous appearance of the forest through which the Landes Railway passes. As undulating ground, however, it is not quite so uninteresting, for the wooded sand-hills behind Arcachon, the valleys between them and the old forest of La Teste in which may be seen a few old Oaks, have a considerable

attraction; while at the foot of the porphyritic cliffs of Corsica old Pinasters, which have never been tapped for resin, raise their heads in the midst of Oak forest and occasionally form a sufficiently pretty landscape. But it is utility, and not beauty, which forms the true merit of the *Pinus maritima*.

The *Pinus Laricio*, or Corsican pine, is only found in the mountains. In Corsica it leaves the lower ground and the hot sunny slopes to the Pinaster, and rises itself between the altitudes of 1,000 and 1,600 metres. It is still found in different countries such as: in Spain round Maladetta, in Italy chiefly in the Calabrian mountains, in Sicily up to 2,000 metres on Mount Etna, on Mount Athos in Macedonia, on Ida in Crete, and in the mountains of Asia Minor. It advances into the interior of Europe by Carinthia, Styria and the Austrian Alps as far as Moravia and Galicia; but in the basin of the Danube it is relegated to the warm slopes of the lower hills, and there has been a quite different appearance, giving a separate variety.

There are few large forests of the Laricio, though single trees are often very fine. In the forest of Casamenta, in the commune of Ghisoni, specimens may be seen with 30 to 40 metres up to the first branch, and 1 metre in diameter at the base, with a clear cylindrical stem crowned with a flattened head of foliage. The Calabrian tree is still more remarkable, for its lofty bole is only crowned by short, weak branches, and one could almost liken it to the mast of a ship. The Austrian tree, or black pine, has a different shape; it is the opposite of the lofty tree of the granitic soils seemingly all trunk, but a stunted tree, almost entirely foliage, of stony calcareous and dolomitic soils. This variety is chiefly remarkable for its accommodating itself easily to the most stony land of Central Europe, in the same way as the *Pinus sylvestris* does to the poorest sands; it keeps in the moisture by its thick rich cover, and besides its rapid growth it has the faculty of germinating easily in places devoid of all other forest vegetation. The black pine may be recognized, not only by its brown back, hard dark green needles and leaves often more than a decimetre in length, but especially by its large leaf buds, thick shoots and generally strong and

vigorous aspect. It may then be looked to as an example of a fact which has been thought to apply to pines in general; that is, that among them the strong growing vigorous species have a large terminal leaf bud at the extremity of a thick terminal shoot.

(*To be continued.*)

Remarks on the Counting of Annual Rings in Trees.

TO THE EDITOR OF THE "INDIAN FORESTER."

SIR,—Those of your readers who take an interest in the rate of growth of trees, or who amuse themselves with the commendable pastime of counting annual rings, are possibly acquainted with what Mr. Fisher has done in Assam with regard to Sāl. The results obtained by him have been published in the last three or four Assam Forest Administration Reports, and they show, among other things, the number of rings counted along mean radii of certain lengths. I have *not the reports* by me, but if my memory serves me right, these radii were four in number, and were respectively 2·″87, 5·″73, 8·″6 and 11·″46 in length. These radii correspond to girths of 1, 2, 3 and 4 cubits, or in other words they are radii of circles whose circumferences are 18 inches, 3 feet, 4 feet 6 inches and 6 feet in length, respectively.

Now if we examine a Sāl stump and mark along its mean radius these different lengths, and count the rings in each space, we shall find, say, (for the numbers do not for my purpose matter in the least) 28 rings in the first, or 2·″87 length, 25 in the next, and so on. We then tabulate them, as Mr. Fisher did, and put 28 rings in the 2·″87 column, 53 rings in the 5·″73 column, and so on. But (granting the hypothesis that these rings are annual, and may be depended upon to tell us the age of the tree,) if we go further, and say that it took 28 years for this particular tree to attain a girth of 18 inches, and 25 more years, or 53, from the start, for it to attain a girth of 3 feet, we are wrong; we are not treating Sal fairly; we have allowed nothing for his bark. Of the 5·″73, which was his total radius when he was 3 feet in girth, it is certain that something like half an inch was bark, and therefore we ought to have drawn our line at 5·″23 along the radius and stopped *counting* there. In this case, we should probably have found only 48 rings (taking on an average 10 rings to an inch, which is very nearly what Mr. Fisher arrived at), instead of 53. Similarly the radius of 2·″87 also includes some bark,

though not perhaps half an inch. Allowing ·2″ for bark, we shall get 26 rings instead of 28: thus this tree would have attained the dimensions of Class IV in 26 years, and those of Class III in 48 years, while it would have taken 22 years, instead of 25, to increase in girth from 18 inches to 3 feet. I have purposely taken an instance which does not exaggerate the case. We should find the difference more striking, though never very great, if we had taken a tree in the higher classes.

There are many trees of which we can count the annual rings, but there are not many which it is necessary to examine in this manner for the purpose of framing working plans. Still all those that we have to so examine are important; they include all the conifers, besides Teak, Sāl, and perhaps some others. Among the conifers there is one tree which it would be highly injudicious to treat by Mr. Fisher's method, and that is *Pinus longifolia*. If we neglected the bark of this tree, our working plan would rest on a false basis; and the time is perhaps not far distant when forests of this species will be regularly treated in accordance with working plans, framed on girth-classes. I submit, then, that in estimating the ages at which trees attain these different girths, we ought not to take Mr. Fisher's radii, but some others less than his in all cases, and differing for the various species.

It will be said by some of your readers, "Oh! but you don't know the bark-thickness of the different trees at these different ages"; and so Mr. Fisher's method, which applies equally well to every case, is the better one to employ; and besides the difference after all is so trifling. I reply: "Quite true as to ignorance of bark-thickness; but this is easily remedied by taking a series of measurements for the different species—and after all they are very few in number—and thus you will obtain the average thickness of the bark of each species for the different girth-classes; these numbers you will subtract from the theoretical or total radii given above, and you will get a true result. And the second part of your argument has yet to be proved. It is not at all certain that the difference is so trifling that it may be neglected; and if ever you come to work forests of *Pinus longifolia*, regularly, by means of work-

ing plans, you will find that this difference will be an important element in your calculations. The same will probably hold good for Sāl Forests, as Sāl too has rather a thick bark."

What we have to draw up for each species whose annual rings we are anxious to count, is a tabular statement as follows :—

Girth.		Total radius.	Deduct for bark.	Length of radius on which rings are to be counted.
feet	inches.	inches.	inches.	inches.
1	6	2·865	·115	2·75
3	0	5·730	·230	5·50
4	6	8·595	·345	8·25
6	0	11·460	·460	11·0

The figures in the third column are what we have to determine by actual observation; they are merely filled in here so as to be an approximation to the truth, and to serve as an example.

We want these observations taken for all the conifers, for Teak, Sāl, and other trees. Will any of your readers undertake this and record their results in the "FORESTER"? They cannot fail to be most useful. I am having observations taken with regard to the two Himalayan Firs, and hope shortly to have some figures for Deodar, and when they are ready, I hope to send them to the "FORESTER."

I remain, Yours truly,

KARSHU.

Value of Annual Rings.

TO THE EDITOR OF THE INDIAN FORESTER.

SIR,—I have been brought up under the belief that the concentric rings so distinctly visible in the wood of coniferous trees are indicative of the age of the tree; that if, on examining the stump of a Pine or Silver Fir, you find 200 rings, the tree which formerly grew there, was 200 years old, or it may be 4 or 5 years older allowing for rings not visible at that height which were formed by the seedling while it was still very small. This idea was thoroughly instilled into us at Nancy, and woe betide any one who dared to hold a contrary opinion. There is a sentence too in Brandis' "Forest Flora," p. 503, beginning "the annual rings are, as a rule, distinctly marked, &c.;" he is talking of conifers, and says that these rings are annual.

In the various preliminary working, plans which have been made for our Himalayan Forests, it is clearly foreshadowed, though not stated expressly in terms, that the future working-plan will be based on this assumption, that concentric rings in conifers are annual.

I was therefore much astonished the other day—and not only astonished but alarmed and shocked—a shock I have not quite got over yet—to read in a pamphlet written in 1866 by M. Patel, not the *patel* of an Indian village, but a Member of the Council General of the Department of the Doubs in France, an opinion which leads to an opposite conclusion. He is speaking of the working-plans made by Forest officers in France for coniferous forests, and says that "they (the officers) give the tree the same age in years as the number of rings they pretend they can count on the tree's stump, taking as one ring the zone formed by a band of soft and a band of hard wood" (meaning, of course, the spring and the autumn wood.)

"They admit this counting as an axiom, and do not give themselves the trouble to prove it. Agriculturists, however, are not agreed on this point; some think that the soft and the hard bands should count as two; others that a band is only formed

every two years; others again are of opinion that it takes several years to form one ring." And then he quotes the Marquis of Chambray, who, in a practical treatise on conifers (1845), wrote as follows:—

"One of my friends, who had charge of a Silver Fir Forest, counted the number of rings on a tree whose exact age he knew, and found it three times as great as the number of years."

Lastly, he quotes M. Baillon, Professor of Botany at the Paris School of Medicine, who says that "the age of a conifer cannot in the least be determined by counting the number of rings from the centre to the circumference. First of all, because conifers have no spiral vessels, and are evergreen. These concentric rings are not due to the fibres and vessels alternating, but to different colours resulting from the intricate interweaving of these fibres.

"If experience has ever shewn that a coincidence exists between the age of a Silver Fir and the number of its rings, it is a coincidence and nothing more; theory completely spurns the idea of exact conformity between these two orders of facts. Thus in the museum," (probably at Paris) "may be seen a large section of a conifer which according to its label is 220 years old. To my thinking it must have been 600 years old."

M. Patel himself, it appears, made several experiments in this direction, and came to the same conclusion. Further on in his pamphlet he quotes an instance of a section of a Silver Fir tree sent by some Forest officer to an exhibition at Nancy or at Metz; it was 28 inches in diameter, and the most careful counting only yielded 120 concentric rings; hence they could not possibly be annual rings, as no one in his senses would imagine that, even under the most favorable conditions of soil and climate, a Silver Fir could grow to this size in the short space of 120 years. M. Patel thus proves entirely to his own satisfaction that no working-plans of any value can be based on such uncertain, aye, erroneous foundations.

Now, Sir, all this is in flagrant opposition to what we were taught at Nancy, and to what has since then been inculcated into us in India. Can any of your readers appease the troubled state of my mind by giving me some direct proof of the

relation between the concentric rings of a conifer and its age? There surely must be several plantations at home of known age which have been examined for annual rings. I only want conifers; for Teak for instance we have a direct proof that the concentric rings *are* annual in the case of the Nelambur plantations in Madras, but for conifers I do not recollect ever having met with such convincing proof; some of your readers can doubtless supply my want.

Yours truly,
A STUDENT.

Some Fungi on living plants in the N. W. Himalaya.

BY M. C. COOKE.

6157.—*Æcidium Solani*, Mont.

On leaves of *Solanum*. Sutlej Valley. (Mr. Gamble). This appears to be the species described by Montague from Chili. It is a rare circumstance to find species of *Æcidium* attacking Solanaceous plants.

6157 *bis*.—*Puccinia Solani*, Cke.

Caulicolous. Sori nearly black, small, linear, buried beneath the hairs of the plant so as scarce to be distinguished. Spores elliptical, slightly constricted, pale brown (·04 × ·018—·02 m.m.) on very slender, long hyaline pedicles.

On stems of *Solanum* with the above. The fungi were on the leaves of a shrubby white-leaved *Solanum*, found by Mr. Gamble on rocks at the Kot bridge, in the Sutlej Valley. According to the theory now in vogue, the *Puccinia* is a stage or condition of *Æcidium*. This is, however, an assertion too sweeping to be applied universally to all species, without proof. At present we are not prepared to assent to it.

6220—*Æcidium urceolatum*, Cke.

Caulicolous, and epiphyllous, distorting the stems and leaves. *Peridia* densely gregarious, elongated, urceolate, sulphury yellow, spores orange, ovate.

On *Thalictrum*. Collected by Mr. C. E. Fendall, Asst. Cons. of Forests at Paugi. Kanawar, 8,000 feet.

This evidently differs from *Æcidium Thalictri*, Grev., the spores are larger, ·025—·03 × ·02 m.m., whereas in *Æ. Thalictri* they are ·022 × ·015 m.m. The latter species is also entirely confined to the leaves, which are never distorted, whereas the present species distorts the plant in a most decided manner. The form of the *peridia* is also different.

6272.—*Coleosporium pingue*, Lev.

On leaves and petioles of *Astilbe rivularis*. Simla, 8,000 feet. (Mr. Gamble).

6235.—*Lecythea epitea*, Lev.

On leaves of *Salix daphnoides*. Gowai, Simla, 6,500 feet. (Mr. Gamble.)

The leaves were also plentifully covered with the ubiquitous *Eurotium herbariorum*, Lk.

5910.—*Æcidium Violæ*, Schum.

On leaves of *Viola*. Simla, 6,500 feet (Mr. Gamble).

The common European and American species.

6014.—*Lecythea Ruborum*, Lev.

On leaves of *Rubus ellipticus*. Jander, Sutlej Valley, 3,000 feet (Mr. Gamble).

This fungus is also common to Europe and America.

6032.—Branches of *Andromeda ovalifolia*, covered with a brilliant crimson fungus-like mass.

This is a curious condition of metamorphosed tissue, in which the cells are extended in the form of thick clubbed hairs, in this instance, of a beautiful magenta color. The condition thus represented is very common in temperate countriest on the leaves of deciduous trees, and formerly was regarded as a fungus, of which there were many forms described as species under the name of *Erineum*. This peculiar disease has never been satisfactorily explained, except to show that it is an extension of the tissues of the plant itself, and not a parasite.

5895, 5898.—Much more resembles a fungus, bursting through the cuticle of the petioles of leaves of *Rhododendron arboreum* and along the midrib. The gregarious convex bodies are of a waxy consistence, and appear to spring from the ligneous

portion of the petiole. They are entirely composed of compact septate threads, closely adherent in a mass. There is no mycelium, and no spores, no evidence of a fungus. As far as we can judge this is entirely a condition of atrophy. What is the predisposing cause is not apparent. It *may* be that the stimulation has been caused by the puncture of an insect.

6229.—*Uredo hypericorum*, DC.

On leaves of *Hypericum cernuum* (but immature). Simla, 6,500 feet (Mr. Gamble).

The spores are in too imperfect a state for positive assurance, that this is the same as the European species, but it is probable.

The Rain Tree.

At a meeting of the Committee of the Agri-Horticultural Society of Madras, held at the gardens on the 7th instant, the Honorary Secretary reports that the seed received from Kew and from Dr. King, of Calcutta, acknowledged in the Proceedings for last month, and said to be that of *Pithecolobium Saman*, has germinated and grown freely, the young plants appearing to be identical with a tree long known to him in Madras as a marvellously fast growing and beautiful one, under the name of *Pithecolobium umbellatum*. A specimen in the gardens, as far as can be ascertained, under six years old, now measures in girth 5 feet 5 inches at the ground, 4 feet 1 inch at the height of three feet, and 3 feet 10 inches just below the first branch 6 feet 8 inches up; it is by measurement about 40 feet in height; and it has a spread of about 70 feet in diameter from north to south, and about 160 feet in circumference. This tree has produced seed. Mr. Deschamps has several trees a year or two older, which produce seed freely. A young Pithecolobium tree was planted by Mr. Steavenson in the compound of the Madras Club on 27th November last, when about 2 feet high, and is now about 10 feet high. On 7th October last, Mr. Steavenson planted two *Pithecolobium* trees of about 2 feet high, in low ground, sheltered by *Casuarina* trees, amongst the sand-hills on the sea shore, at Sholanganellore, fifteen miles south of Madras, which now measure, the one 13

feet and the other 12 feet in height. The tree is evidently of great value, though much more will doubtless be known of it in a year or two, now that special attention has been called to it. The grass does not seem to grow very well under the specimen in the gardens, the shade being apparently too dense. There are in the gardens four plants received from Mr. Cameron, of Bangalore, under the name of *Pithecolobium Saman*, and acknowledged in the Proceedings of 3rd January 1877, which differ most materially from that, the seed of which has now been sent to us from Kew, and in which the Secretary of State for India is said to be taking so much interest. It may not be generally known that the Coorkappillay (*Inga dulcis*) the commonest hedge plant of Madras, of which the leaves and pods are so largely used as fodder, and the timber as fuel, is also known to botanists as *Pithecolobium dulce*. In a letter from Colonel Beddome, the Conservator of Forests, just received, he states that the *Inga Saman*, mentioned in his last Forest Report, as growing in the plantations in Cuddapah, North Arcot and Tinnevelly, is the same tree as that of the seed of which Government has lately sent him a large box under the name of *Pithecolobium Saman*, that it is a West Indian tree, and that he introduced it ten or twelve years ago. The Society now has ready for distribution a large number of fine young plants, raised from the seed received from Kew, from Dr. King, and from Mr. Deschamps.—*From the "Madras Mail" of the 22nd August* 1878.

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Memorandum on the rate of growth of Teak.

By D. Brandis,

Inspector-General of Forests.

CONTENTS.

For the Manual of Indian timbers, now under preparation, it was necessary to bring together all information available regarding the rate of growth of Teak, and it appears advisable to circulate the results at once with the view of eliciting further data in order to complete the account that will be given in the Manual. The following data were brought together with the assistance of Mr. A. Smythies, Assistant Conservator of Forests, Forest School Circle, North-Western Provinces.

2. A brief account of what was known regarding the rate of growth of Teak up to 1873 was given on pages 357-359

of the Forest Flora of North-West and Central India. Since then, further data have been collected; but the chief addition to our information on this subject has been made by the publication of Colonel Beddome's Report of 1878 on the Nilambur Teak Plantations. The data here brought together in no way give a complete account of the rate and mode of growth of Teak, and doubtless much more information is available which has not yet been published. It is a most important subject, which should now be taken up separately in each province where Teak is cultivated on a large scale, and its study is earnestly recommended. The following remarks will most conveniently be grouped under the head of annual rings, girth and height at different ages, cubic contents of individual trees, and the number of trees and cubic contents of growing stock per acre. It will be remembered that the rate of growth of every species varies between wide limits according to climate, soil and numerous other circumstances which affect the development of trees.

3. *Annual rings.*—It is now established beyond doubt that the concentric rings which are so marked in the wood of Teak correspond each to one year's growth. The following statement exhibits the rings counted on sections of trees grown in the Nilambur Plantations, which were cut in 1877. The sections were taken from the base of the stem, and, with a few exceptions, the number of rings agrees with the age of the tree. The average diameter is the mean of three diameters. The statement shows the gradual increase of the heart-wood as the tree grows older, and it also exhibits the number of rings on one inch of average radius in the wood of trees of different ages. But it must be borne in mind that these sections do not rep resent the average of each year's plantation, but were selected from among the dominant trees. They, therefore, exhibit a more rapid rate of growth than average specimens would do :—

Year of plantation.	Number of rings counted.	Average diameter of section (wood only.)	Average diameter of heart-wood.	Rings per inch of average radius.
		In inches.	In inches.	
1844 ...	33	20·8	19·3	3 17
1845 ...	31	21·1	18·7	2 95
1846 ...	31	20·	17·7	3·10
1847 ...	30	23·8	21·5	2 52
1848 ...	28	16·7	15·4	3 34
1849 ..	28	18·1	16·2	3·09
1850 ...	27	14·	12·5	3·85
1851 ...	25	15·2	13·4	3 28
1852 ...	32*	15 2	13·5	Omitted.
1853 ...	24	15·1	12·	3·17
1854 ...	24	17·3	15·2	2·77
1855 ...	23	12 4	10·5	3·71
1856 ...	21	15·2	12·6	2·76
1857 ...	20	12·2	10·6	3·27
1858 ...	19	14·	11·3	2 71
1859 ...	18	14·	10·6	2·57
1860 ...	17	12·9	10·4	2·63
1861 ...	16	13·1	10 5	2·44
1862 ...	15	11·7	9·	2·56
1863 ...	14	13·6	10 4	2 06
1864 ...	13	12·5	9·4	2·08
1865 ...	12	9·4	6·9	2 55
1866 ...	11	10·4	7 3	2·11
1867 ...	10	11·8	8·3	1·69
1868 ...	9	10·5	7·6	1·71
1869 ...	8	7·4	4·8	2·16
1870 ...	7	7·4	4·5	1·89
1871 ...	7	7 7	4 3	1·81
1872 ...	5	6·5	2·6	1·53
				Average 2·62 rings per inch of average radius.

4. The sections ranged in age from 5 to 33 years. Dividing them into three groups, two of 10 years each, and the third of nine years, we obtain the following as the mean diameter in inches of these three groups :—

		Inches.
Mean diameter of trees	5—14 years old ...	9·72
	15—24 „ ...	13·79
	25—33 „ ...	18·71

* There is evidently a mistake here. The tree which yielded this section must have been an older tree standing in the plantation of 1852.

A section sent from the Thinganneenoung Plantation in Burma, cut from a tree 21 years old, planted in 1856, gave 21 rings on a mean diameter of 16·3″, the heartwood of which occupied 14·5″. This section showed 2·57 rings per inch of average radius.

5. From other plantations also, sections of Teak trees of known age were sent for the Paris Exhibition, but apparently they were not in all cases cut from the base of the stem; they are, however, instructive as showing the rate of growth and the number of rings on one inch of mean radius.

Year of plantation.	Number of rings counted.	Average diameter of section in inches.		Rings per inch of average radius.
		Wood.	Heartwood.	
South Kanara (Panappa Plantation).				
Not known ...	10	9·	4·9	2·22
" ...	5	5·6	2·5	1·81
North Kanara (Kalanadi Valley).				
Sulageri, 18 years old	18	8·	6·	4·5
	17	8·8	7·5	3·9
	17	9·	7·	3·7
Murdi, 12 years old	8	7·5	Heartwood not distinct.	2·1
	11	6·		3·7
	11	5·7		3·8
Kadra, 10 years old	8	6·5	...	2·5
	8	7·5	5·	2·1
	7	7·	4·	2·
Bengal (Bamunpokri).				
1868	8	6·5	2·5	2·5
1871	6	6·	1·	2·
1872	4	5·	1·	1·6
Andamans (Port Blair).				
1873*	6	10·1	6.	1·2

6. It will be noticed that, as far as the data go, which are furnished by the sections received, Thinganneenoung and Bamunpokri exhibit an increase of diameter similar to that of Nilambur; while in the samples from North Kanara the annual rings are much narrower, and the specimen from Port Blair showed an extremely rapid rate of growth.

Girth and height at different ages.—The following measurements illustrate the rate of growth of Teak in plantations in

*The tree was probably older.

different provinces as nearly as possible from 5 to 5 years. The Nilambur Plantation again furnishes the largest amount of information :—

Age.	Mean girth at breast high.	Total height of tree.
Nilambur Plantation.—Alluvial soil.		
3—7 years ...	12 inches ...	29 feet.
8—12 „ ...	17 „ ...	63 „
13—17 „ ...	23 „ ...	68 „
18—22 „ ...	25 „ ...	71 „
23—27 „ ...	27 „ ...	77 „
29 „ ...	34 „ ...	87 „
30 „ ...	35 „ ...	85 „
31 „ ...	32 „ ...	75 „
32 „ ...	34 „ ...	92 „
33 „ ...	37 „ ...	95 „
Nilambur Plantation.—Gneiss and laterite.		
7 years ...	13 inches ...	30 feet.
16 „ ...	14 „ ...	50 „
20 „ ...	21 „ ...	50 „
24—26 „ ...	22 „ ...	52 „
30 „ ...	24 „ ...	50 „

These figures are taken from that portion of Colonel Beddome's report (paragraphs 11— 44) which contains his notes on each year's plantation, and the data recorded are stated to be average figures.

8. In another part of his report (paragraph 81), however, he gives data which would seem to show that the average size of the trees in the older plantations (all on alluvial soil) is considerably greater. He there states the dimensions of the largest, smallest and medium-sized trees, four plantations, the results being as follows :—

Age.	Mean girth (probably breast high.)			Length of bole.		
	Largest.	Medium.	Smallest.	Largest.	Medium.	Smallest.
	Inches.	Inches.	Inches.	Feet.	Feet.	Feet.
30 years ...	67	47	29	79	65	50
31 „ ...	69	49	30	80	65	50
32 „ ...	63	46	30	83	67	50
33 „ ...	68	56	43	86	68	50

The first three lines show the average of 6 trees in each case, and the last line the average of 8 trees each. It is distinctly stated that the length is that of the bole, and not of the entire tree.

The plantations made on gneiss and laterite show a much slower rate of growth than those on alluvial soil ; the difference being considerable in height, and much less in girth.

9. Up to 10 years of age, the growth in length of teak on alluvial soil at Nilambur is at the rate of about 6 feet a year, and later on it is at the rate of only about 1 foot a year. On page 358 of the Forest Flora of North-West and Central India it is stated " that it is probable that, as a rule, Teak attains half its length with a girth of 2—3 feet." This assumption is borne out by the present figures. The trees grown upon alluvial soil in girth between 25 and 34 inches are from 77 to 87 feet high ; and from all that is known regarding the growth of Teak in similar localities, it is probable that unless damaged by storms, disease, insects, or other causes, they will attain a height of 150 feet in soil of this description, and in the climate of Nilambur.

10. From Burma we have the following data. The figures from Pegu represent averages of plantations in the Rangoon, Toungoo and Tharawaddee districts, brought together on page 358 of the Forest Flora of North-West and Central India :—

	Age, in years.	Mean girth, breast high, in inches.	Total height of tree, in feet.
Pegu	4	5—9	15—27
	10	15	40—45
	15	23	...
Thingauneenoung... ...	21	27	50—60
Garden—Moulmein	22	40	...

The fourth line is the average of 150 trees in the Thinganneenoung Plantation in the Attaran district of Tenasserim, given in paragraph 146 of the report for 1876-77 of the Tenasserim forests. Major Seaton gives the average height at 30—40 feet, but this probably means the height to the first

branch. The maximum girth was 55½ inches. The average rate of growth of the present plantations in Burma is somewhat less rapid than that of the alluvial portion of Nilambur. The last line gives the average of 15 trees measured in 1856 in a private garden at Moulmein. An instance of extremely rapid growth was the tree already mentioned, a section of which was sent from Port Blair for the Paris Exhibition, probably 6 years' old (said to have been planted in 1873, but 6 rings were counted), with a girth of 36 inches and a height of 44 feet.

11. For the Lakvalli Plantation in Mysore, the following data are given in Captain Van Someren's report for 1875-76. Age 13—15 years, mean girth 14 inches, height 32 feet. This is a remarkably slow rate of growth, considering that the soil is good, and the climate moist, though of course not so forcing as the climate of Nilambur.

12. The plantations in the Central Provinces and Berar have given the following :—

Plantation.	Age, in years	Mean girth, breast high, in inches.	Total height of tree, in feet.
Machna, Central Provinces ...	6	7	15—22
Pili, Berar	6	4	10
Sakata, Central Provinces ...	7	11	20—25
Pili, Berar	8	8	20
Sonawani, Central Provinces ...	9	12	30—40
Machna, Central Provinces ...	8—10	9	17—30

Compared with Malabar and Burma, the rate of growth is slow, as may be expected in a dry climate and near the northern limit of the tree.

13. Outside the range of the natural growth of Teak, the following data, regarding its rate of growth, are available :—

Plantation.	Age, in years.	Mean girth, breast high, in inches.	Total height of tree, in feet.
Bamunpokri (Sikkim) ...	5	5·5	12—15
Kulsi (Assam)	5	11	29
Makum ,, ...	4	9	18
,, ,, ...	5	11	27
,, ,, ...	7	16	31

The growth at that early age is fairly good; but it does not follow from these figures that Teak in Assam and Sikkim will attain a great age, and produce good timber.

14. The following instances of older trees of known age in Assam and Bengal are on record :—

Locality.	Number of trees measured.	Age, in years.	Mean girth, in inches.
Gauhati, banks of the Brahmaputra	15	37	85
Royal Botanical Gardens, Calcutta	19	6	16
Ditto ditto ...	8	70	79
Garden at Mohesh, Serampore...	27	50	52

The trees at Gauhati were on an average 30—50 feet high.

The trees in the Botanical Garden, Calcutta, were measured in January 1856. The older trees have since been blown down by the cyclones of 1864 and 1867.

On the banks of the Hooghly at Mohesh, below Serampore, stands a grove of Teak trees planted in 1828. Their mean girth, breast high, taken by measuring 27 average-sized trees, was 52 inches. The trees were measured in January 1878, and were therefore 50 years old. They are from 40—50 feet high.

15. In paragraphs 177 and 183 of Dr. Schlich's report for 1872-73, the dimensions of a large number of Teak trees at different stations of Lower Bengal are given; but unfortunately no trustworthy information regarding their age is available.

16. *Cubic contents of trees at different ages.*—In paragraph 4 of Colonel Beddome's report a statement is given exhibiting the dimensions of the trees, sections of which were sent to the Paris Exhibition. As already stated, these trees were selected as samples of the dominant trees, *viz.*, of those which will eventually be selected to remain on the ground as the ultimate crop; but, with few exceptions, they were not selected from among the largest individuals which had much outrun their neighbours. Arranging them in groups from 10 to 10 years, the following results are obtained :—

Age.	Height of tree, in feet.	Girth at base, in inches.	Length of bole, in feet.	Mean cubic contents, in cubic feet.
4—13 years ...	48—75	21—60	32—56	10·6
14—23 „ ...	65—110	51—69	40—70	23·8
24—33 „ ...	70—110	60—105	41—72	51·3

This gives us the cubic contents at different ages as follows :—

Mean age.	Cubic contents, in cubic feet.	Periodical annual increment, in cubic feet.
9	10·6	1·1 to 9 years.
19	23.8	1·3 from 9 to 19 years.
29	51·3	2·8 from 19 to 29 years.

The annual increment increases steadily to the age of 30 years, and probably continues increasing for a considerable time beyond it.

17. *Number of trees and cubic contents of growing stock per acre.*—Regarding the number of trees and the growing stock per acre at different ages, we depend almost entirely upon Nilambur for our data. Sample areas of half an acre each were selected in each of seven plantations; each tree was measured, the cubic contents determined, and the following is the result. It is not expressly stated, but it is probable that these sample areas were all selected on alluvial soil :—*

* The length of stem to the top of sale measurement, where the head begins, of every tree in the plantations of 1844 to 1848, both inclusive, was measured by sending up a climber with a tape. In the plantations of 1858 and 1868 a large number of felled saplings were available, of which the average was taken.

The mean quarter girth was determined in the following manner:—Ten saplings were measured breast high, and in the middle of the stem at half its length, and this gave $\frac{4}{5}$ as the reducing factor. Those trees 30 inches in girth breast high were found to have a girth of 20 inches in the middle of the bole.

Name and year of plantation.	Age of plantation, in years.	Number of trees per acre.	Average length of bole, in feet.	Mean quarter girth of trees, in inches.	Cubical contents in cubic feet.		Average annual increment, in cubic feet.	
					Per tree.	Per acre.	Per tree.	Per acre.
Iravelly Kava...1844	33	120	59	9·7	41	4,879	1·2	148
Elanjerry ...1845	32	158	61	7·9	30	4,742	·9	148
Elanjerry ...1846	31	156	60	7·4	27	4,204	·9	136
Moolathamanoo 1847	30	140	62	7·5	27	3,713	·9	124
Moolathamanoo 1848	29	156	60	6·8	21	3,243	·7	112
Elanjerry ...1858	19	270	45	5·0	8	2,203	·4	116
Wallashary ...1868	9	750	40	3·4	3	2,491	·4	277

18. Colonel Beddome estimates that on alluvial soil, the Teak at Nilambur will reach maturity at from 60 to 80 years; that fellings will be spread in each plantation over 50 years; and that at the time of cutting (say at 85 years of age) the mean quarter girth will be 2 feet, the length of bole will be 70 feet, and the mean cubic contents of each tree 280 cubic feet. He also estimates that, at that age, there will only be 60 trees to the acre, making the cubic contents per acre 16,800 cubic feet.

No safe speculations can be formed regarding the future of a pure Teak forest like that of Nilambur. In its natural state, Teak does not grow alone, but is associated with Bamboos and a variety of other trees; and it is impossible to foresee the risk of damage by storms, insects, disease, or other causes to which pure Teak forests may be exposed. It may be doubted whether, even on the best alluvial soil, the average mean girth of trees 85 years of age will be as much as 8 feet. On the other hand, it is not impossible that the bole will be longer than 70 feet, and it is probable that it will be advantageous to allow more than 60 trees per acre. On page 155 of the Attaran Report of 1860, a plot in the Tsintsway forests (Yoonzaleen) is described, measuring 3,833 square feet, and stocked with 8 Teak

trees with clear stems to the first branch of 50 feet, the girth between 4′ 6″ and 6′ 5″; this would give 91 trees to the acre. Full stocked forests of Oak and Beech in Europe 130—180 years old under favourable conditions contain 120—140 trees per acre, with a cubic content (including tops and branches) of about 11,000 cubic feet. A forest of Silver Fir in the Jura, 180 years old, was found to contain 94 trees per acre, with a cubic content of 16,000 feet.

19. The total area now stocked at Nilambur is 3,436 acres, of which 1,787 are stocked with a full crop on alluvial soil, the rest not being expected to yield a full crop. In his estimate of the future value of the plantations, Colonel Beddome only assumes 6,000 cubic feet as the full crop expected on alluvial soil.

In natural forests, where Teak is associated with Bamboos and other trees, the number of the first and second class Teak trees (above 4′ 6″ in girth) rarely attains 10 trees per acre over large areas. The following are instances of forests exceptionally well-stocked with Teak :—

Date of survey.	Forest.	Area.	Number per acre.		Total.
			Class.		
			Girth above 6 feet.	Girth 4½ to 6 feet.	
1876 ..	Bimaram (Central Provinces.) ...	50 acres ...	4	4·3	8·3
1870-71 ...	Pegu (Prome District) ...	17 square miles	3·6	3·0	6·6

Sketch of the Flora of Rajputana.

By George King, M.B., F.L.S.,
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As might be expected from its geographical position and limited rainfall, the flora of Rajputana is not a rich one. The number of indigenous species is but small, and few of these are attractive in appearance. The province is divided by the Arvali range of hills into two unequal parts—the part to the eastward of the range lying in the basin of the Chambal, and that to the westward in the basin of the Indus. This division is, to a great extent, coincident with certain features in the physical configuration, meteorology and vegetation of the province; and these two portions may, therefore, be conveniently treated of separately. The vegetation of the dividing range itself, and of the outlying mountain mass of Aboo, so much more resembles that of the eastern than of the western tract, that it may be treated along with the former.

Eastern Rajputana.—The country to the east of the Arvali is (with the exception of the Jaipur State) more or less hilly, and has a climate and a flora resembling those of Central India and the North-Western Provinces. Where not actually hilly, the surface is, to a considerable extent, undulating. Cultivation is, on the whole, scanty, and is chiefly confined to the lower and flatter lands, while the higher parts remain to a large extent covered with their original vegetation, and on them may be found in abundance plants which, in the more completely cultivated provinces of North-Western India, are confined to the comparatively small tracts of waste and unreclaimed land.

As is the case in other parts of India with a similar vegetation, the majority of the trees and shrubs come into flower during the hot season, while the herbaceous plants blossom chiefly during the rains. Many of the latter are, moreover, annuals which wither and die as the cold season approaches. The cold season corresponds to the winter of temperate countries, and during the whole of it the aspect of the uncultivated parts of the country is brown and barren. The flowering of the shrubs and trees during the hot weather does little towards increasing the beauty of the scenery. On the contrary, it, if

anything, intensifies the feeling of barrenness and aridity. With the first fall of rain, myriads of seeds that had lain dormant in the parched soil spring into life, and in the course of an incredibly short time the whole of the country, even to the tops of the barest hills, is clad in a carpet of delicate green, while the pleasant sound of running water can actually be heard in the valleys. The largest tree of this part of Rajputana is the Semul (*Bombax malabaricum*), which on the Arvalis and Aboo attains a considerable size. The finely buttressed grey trunk, spreading arms and gaudy red flowers of this species make it a striking object in the landscape wherever it occurs. Ranking after the Semul in size are *Prosopis spicigera*, *Sterculia urens*, *Semecarpus Anacardium*, the two Acacias (*leucophlæa* and *Catechu*), *Anogeissus latifolia* and *pendula*, *Dichrostachys cinerea*, *Cordia Rothii*, *C. Myxa*, and *Phyllanthus Emblica*. These yield both fuel and building timber in parts of the region where neither is over-abundant. *Erythrina suberosa*, with its ungainly trunk and branches but handsome scarlet flowers, and the pretty geranium tree of the Anglo-Indian (*Bauhinia purpurea*), are not uncommon. *Gmelina arborea*, a tree which yields an excellent timber, and which occurs over almost the whole of India and Burma, is found sparingly in the Arvalis. The gum-yielding salai tree (*Boswellia thurifera*), so abundant in the territory to the eastward of the tract, is not uncommon in Meywar and the Arvalis. The dâk or pallás (*Butea frondosa*), which in various parts of Central India covers immense areas to the exclusion of pretty nearly every other tree, is far from abundant in any part of the region. Two Terminalias (*tomentosa* and *Arjuna*), both valuable as timber trees, occur sparingly on the eastern frontier of the tract, but are rare elsewhere. *Schrebera swietenioides*, a little-known and rather rare tree, has been found by Dr. Brandis in Meywar.

Climbing plants are not numerous, the most notable being two species of Cocculus (*villosus* and *Leœba*), *Cissampelos Pareira*, *Celastrus paniculatus*, two vines (*Vitis carnosa* and *Vitis latifolia*), and *Mimosa rubicaulis*.

The shrubby vegetation, which in every part of the region is so much more prominent than the arboreal, consists largely

of capers, jujubes, tamarisks, and *Grewias*. Of the capers by far the commonest is *Capparis aphylla*, a prickly leafless shrub with a handsome plum-like fruit, which flourishes over all the driest parts of North-Western India, and extends to Arabia, Nubia, and Egypt; *Capparis spinosa* (which yields the eatable caper) is much less frequent; *Capparis horrida*, a scrambling plant which often climbs on trees, is not uncommon; while a fourth species *Capparis sepiaria* (indigenous in the south of India), is here and there cultivated as a hedge plant. The small jujube (*Zizyphus nummularia*) is very abundant, and, covering, as it often does, large tracts of country, has great value as a fodder plant: it is also much used for hedges. *Zizyphus xylopyra* is a less abundant species, which sometimes, in protected spots, attains to the dignity of a small tree and yields a useful wood, while its bark is used in tanning. In every water-course tamarisks of several species abound. One of these (*Tamarix gallica*) is a cosmopolitan plant, which is found in suitable localities all over India and Ceylon, in China, Japan, and Siberia; specimens of it have been gathered in Yarkand, in Thibet, at 11,000 feet above the sea, and it is common in many parts of Northern Africa and Southern Europe. *Tamarix dioica*, an exclusively Indian species, is also abundant. Of the Grewias, *Grewia populifolia*, *Grewia pilosa*, *Grewia villosa*, and *Grewia salvifolia* are the common species. These all yield tough wood, which, however, is rarely large enough to be of much use; and the fruits of all four are more or less eatable. In addition to these, the most notable shrubs are *Helicteres Isora*, the curious spirally curled seed-vessels of which have a fanciful value as a remedy in dysentery: *Celastrus spinosus* and *Celastrus senegalensis*, *Buchanania latifolia*, *Cassia auriculata*, *Woodfordia floribunda* (the scarlet flowers of which are used as a dye), *Casearia tomentosa*, *Diospyros montana*, *Holarrhena antidysenterica* (named from its reputed value as a cure for dysentery), *Calotropis procera*, *Vitex Negundo* (esteemed as a remedy for rheumatism), and *Clerodendron phlomoides*. Two cactus-like fleshy *Euphorbias* (*Euphorbia Royleana* and *Euphorbia neriifolia*) occur in the hills, but are much less abundant than in the tract to the west of the Arvalis.

Bamboos are represented by a single species (*Dendrocalamus strictus*), which attains large dimensions only on Aboo and the higher parts of the Arvalis.

The herbaceous vegetation consists of *Leguminosæ* of the genera *Alysicarpus, Desmodium, Crotalaria, Cassia,* &c., of various widely distributed species of *Compositæ* and *Rubiaceæ*; *Boraginaceæ* being also rather numerous, and *Scrophulariaceæ* less so. During the rains a few *Convolvulaceæ* appear, and grasses and sedges are abundant.

Owing to its heavy rainfall, Aboo is, as regards vegetation, by far the richest spot in Rajputana. On the higher parts of the mountain, humid types appear which are unknown on the plains below. Most noteworthy of these is an epiphytal orchid (a species of *Aerides*) which clings to the mango trees, and in the rains produces fine racemes of delicate pink flowers. The occurrence of a charming white wild rose and of a stinging nettle (*Girardinia heterophylla*) also at once reminds the visitor to Aboo that he has left the arid region below, and recalls to his mind the semi-temperate vegetation of the Himalayas and Nilgiris. Magnificent trees of *Michelia Champaca* are found, especially beside the temples, and weeping willows adorn the margin of the lake near the station; but the latter two species have both doubtless been planted. A yellow jasmine (*Jasminum revolutum*) abounds on Goroo-Sikhur, the highest peak of the mountain; but this is also doubtfully indigenous. *Crataeva religiosa*, with its creamy yellow flowers and delicately-tinted stamens, is common on the middle and lower slopes of the hill; while *Carissa Carandas* is so abundant that during part of the hot season its pretty white flowers scent the air for miles round the station with their delicious fragrance. The prevailing tree on the slopes of Aboo is the mango. It is doubtfully indigenous and was probably originally introduced by the numerous pilgrims who have for ages frequented the sacred shrines for which the mountain is famous. Now, however, it is thoroughly naturalised, and is the commonest of the larger trees. *Pongamia glabra* is found in several of the lower valleys of Aboo (wherever it occurs on the plains below it has usually been planted) and *Sterculia colorata* is not uncommon. Shrubby and

herbaceous *Acanthaceæ* of several species abound. Very common also is *Mallotus philippinensis*, the powder covering the capsules of which forms at once a valuable dye-stuff and an efficient vermifuge. On the lower slopes of the mountain, and in the dense belt of jungle which surrounds its base, are found most of the species which are characteristic of the plains. Many of the latter (for example, *Salvadora persica*) ascend to the very highest peaks of the mountain, and thus intermix with the more temperate forms which are confined to the latter.

Of introduced Indian plants which are found usually in gardens or near villages over the whole of the eastern tract, the most prominent are the peepul (*Ficus religiosa*), the banyan (*Ficus bengalensis*), the gular (*Ficus glomerata*), the ungeer (*Ficus virgata*), the mulberry (*Morus alba*), the tamarind (*Tamarindus indica*), the mango (*Mangifera indica*), the nim (*Melia Azadirachta*), the bábul (*Acacia arabica*), the ber (*Zizyphus jujuba*), the siris (*Acacia Lebbek*), the jamun (*Eugenia Jambolana*), the mehndi (*Lawsonia alba*), the pomegranate (*Punica Granatum*), and the peach (*Amygdalus persica*). *Mimusops indica* and *Elengi*, *Ailanthus excelsa*, and *Flacourtia Ramontchi* are also occasionally met with. The bábul is quite naturalised in spots where the winter cold is not too intense, and where the sub-soil retains a little moisture: its timber and bark are both highly prized. Among fruit trees cultivated in gardens, two American species are very common; these are the custard apple (*Anona squamosa*), and the guava (*Psidium Guava*). *Argemone mexicana*, *Parkinsonia aculeata*, *Opuntia Dillenii*, and *Acacia Farnesiana* (also introductions from America), are frequently met with. *Nerium odorum*, a shrub closely allied to, if not identical with, the oleander of Southern Europe, is also common in gardens.

Western Rajputana.—To the westward of the Arvalis the country is much flatter and drier, and as the Sind and Punjab frontiers are approached, it passes into actual desert. It is, however, by no means destitute of hills, for numerous low ridges of a red sandstone rise here and there, and in other parts there are undulating areas of hardened sand. The rest of the

country is for the most part a plain of loose sand, which, everywhere more or less saline, becomes increasingly so towards the south-west, where the Loni loses itself in the Runn of Kutch. Except that they support a few of the fleshy *Euphorbias* already mentioned many of the hilly ridges are utterly barren. The little rain that falls on these bare rocks is at once carried off in rapid torrents which are often lost in the sand at a short distance from their bases. The few torrents which do succeed in carrying their water to any distance unite to form the Loni, the one river of this part of the country. But although water can be had by digging at certain parts of its bed at almost any season of the year, and stagnant pools may here and there be found at all times, it is only during the brief and scanty rainy season that anything like a continued current can be seen in any part of the Loni. The rainfall, which over the whole area is scanty and uncertain, gradually diminishes as the Sind and Punjab frontiers are approached. Erinpura, a station near the base of the Arvalis, has a rainfall of about 12 inches in the year; whereas Western Marwar, Jesulmir, and Bikanir have probably less than a third of that amount.

It must not be supposed that the Arvali range forms a rigid boundary separating two distinct floras; on the contrary, the majority of the plants already mentioned as characteristic of the eastern tracts are found on the west of the range. Near the base of the Arvalis, the soil is good and supports a belt of what would, for Western Rajputana, be a comparatively luxuriant vegetation, were it not ruthlessly preyed on by the inhabitants for fuel and timber for themselves and fodder for their cattle and camels. In passing westward from the Arvalis, such of the species already mentioned as are unable to withstand the increasing dryness of the climate, and the saltness of the soil, are represented in gradually diminishing numbers by stunted, half-starved specimens, and the majority of them finally disappear altogether. On the other hand, a few species of a thoroughly desert type gradually appear, and these latter increase in proportion to the former, until on the western frontier of the region they form almost the entire vegetation. These desert plants are outliers of the Arabian and North African

flora, and are common to all low-level Asiatic deserts, while some of them penetrate even to the comparatively high arid tracts of Central Asia. Next to the floral poverty of this tract, the most notable fact that strikes the observer is the tendency of plants, which in moister regions are herbaceous, here to become tough and shrubby, and of the whole vegetation to develop epidermal armature in the shape of hairs and thorns. The common weed (*Solanum Jacquinii*) which in the Gangetic plain is moderately covered with stiff bristles, here presents the appearance of a vegetable hedgehog. The spines of the bábul are about twice as long and as thick as they are in Malwa, while the small ber bushes, everywhere formidable, are here little more than mere bundles of spines.

The largest trees in Marwar are those that have been planted in gardens and near tanks or wells. Hardly one of any indigenous species is ever found exceeding ten or twelve feet in height. The commonest of these latter are *Prosopis spicigera* *Salvadora persica*, *Cordia Rothii*, *Acacia leucophlœa*, with *Acacia arabica* in the kind of spots already indicated, and *Sterculia urens* on the less barren hills. *Anogeissus pendula* and *Dichrostachys cinerea* occur but sparingly, and hardly ever exceed the dimensions of under-shrubs. Towards the Sind desert, the only tree to be found wild is said to be *Acacia rupestris*, a form almost totally absent from the eastern tract.

By far the handsomest shrub indigenous to this part of Rajputana is *Tecoma undulata*, which has the double merit of bearing large orange-coloured bell-shaped blossoms, and of bearing them simultaneously with its handsome shining leaves. This plant is so indifferent to climatic conditions that, although naturally found on some of the drier ridges of Marwar, it thrives excellently in the Botanical Garden in the steamy climate of Calcutta—a peculiarity which it shares with *Dichrostachys cinerea* and *Acacia leucophlœa*. Next to *Tecoma undulata*, the finest indigenous shrub is *Acacia Jacquemonti*, the polished stems and thorns and sweet-scented yellow flowers of which make it an object of much beauty and interest. In addition to these, the shrubby vegetation is composed of the following species already mentioned as occurring more abundantly in the eastern tract :—

Capparis aphylla and *spinosa*; *Helicteres Isora*; *Grewia populifolia, pilosa, villosa*, and *salvifolia*; the two *Zizyphi* (*nummularia* and *xylopyra*); *Cassia auriculata*; *Clerodendron phlomoides*, and *Vitex Negundo*. The tamarisks already mentioned are found abundantly in the salt-impregnated bed of the Loni, and two other species of the same family (*Tamarix articulata* and *Myricaria germanica*) also begin to be found. Both these are common in Afghanistan and in Western Asia generally; while the second of the two extends also to high altitudes both in the Himalayas and in some of the mountain ranges of Northern Europe. *Balanites Roxburghii* (a prickly scraggy shrub common in Southern India, Central Provinces, and other dry parts of India) is here pretty common. *Balsamodendron Mukul*, a shrub which yields a gum called *mukul* or *gugal*, and which extends to the dry countries far to the westward of India, begins here to be as abundant as east of the Arvalis it is rare. *Ephedra alte*, a bush common in the west of Asia and north of Africa, is said to have been found in Jesulmir. The pretty little camel-thorn (*Alhagi Maurorum*) which, occurring in the eastern tract and far beyond it in India, is also distributed in Southern Europe and Western Asia, here forms a prominent feature in the vegetation of the sandy tracts. Associated with it are a few other bushes, such as *Calotropis procera* and *Orthanthera viminea* (both of which yield an excellent fibre), and here and there *Periploca aphylla*.

Of the herbaceous vegetation, the prominent species may be indicated as follows: *Peganum Harmala* (a rutaceous plant, which is found in the Deccan and Punjab, and which is distributed to the westward along the Mediterranean coasts as far as the Atlantic) occurs in plenty in many spots, as, for example, near Palli. *Polygala abyssinica* is not unfrequent in places. The most abundant leguminous plants are *Crotalaria Burhia* (much valued for fodder) and *Tephrosia purpurea*. *Compositæ* are represented by one or two *Blumeas*, *Vernonia cinerea*, *Microrhynchus nudicaulis*, and *Berthelotia lanceolata*; here and there *Trichodesma indicum* and *Echinops echinata* are to be seen; and near irrigated spots may be met with *Machlis hemispherica*, *Sphæranthus hirtus*, and *Cyathocline lyrata*.

Not uncommon in gardens as weeds of cultivation are *Saponaria Vaccaria*, *Trianthema crystallina*, *Asphodelus fistulosus*, and *Fumaria parviflora*. Of Acanthaceous plants, the most frequent are *Lepidagathis trinervis* and *Barleria noctiflora* with here and there two plants of wide distribution in India,—namely, *Justicia procumbens* and *Peristrophe bicalyculata*. *Boragineæ* are numerous in individuals belonging to the genera *Eritrichium* and *Arnebia*; *Trichodesmus indica* and *Tournefortia subulata* are common near Jodhpur. Several *Cleomes*, one or two *Farsetias*, two or three species of *Abutilon* and *Sida* are also common. *Tribulus terrestris*, *Corchorus depressus*, *Verbena officinalis*, *Lippia nodiflora*, *Bergia æstivosa*, *Cressa cretica*, *Convolvulus arvensis*, *Evolvulus pilosus*, *Withania somnifera*, *Solanum xanthocarpum* var. *Jacquinii*, *Salvia brachiata*, *Polygonum Roxburghii*, and *Aristolochia bracteata* are found in spots where there is a little admixture of vegetable mould, and by the margins of tanks and irrigated spots. *Amarantaceæ* are represented by *Achyranthes aspera*, *Alternanthera sessilis*, *Amaranthus lividus*, *Aerua lanata*, and *Pupalia velutina*. Such *Chenopods* as *Anabasis*, *Atriplex* and *Salsola* abound where, as towards the mouth of the Loni, the sand is highly saline. Parasitic on the roots of *Calotropis* is a pretty species of *Orobanche*. The tanks are not destitute of vegetation, for in their water may be found, though sparingly, *Vallisneria spiralis*, *Utricularia stellaris*, *Potamageton pectinatus* and *natans*, while by their margins several species of sedges, and notably *Hymenochæte grossa*, are often abundant. Several species of *Andropogon*, *Anthisteria*, *Cenchrus*, and other wiry grasses are distributed over the whole area; and towards the Sind frontier one of these, known locally as *mart*, constitutes a large proportion of the scanty vegetation. Besides this grass, the vegetation on that frontier consists almost exclusively of the small acacia tree already mentioned (*Acacia rupestris*), of a plant of the rhubarb family with curious hairy seed-vessels known locally as *phog* and botanically as *Calligonum polygonoides*, the woolly-looking plant *Aerua lanata* (locally called *bhin*), *Anabasis multiflora*, and a troublesome bur grass, *Cenchrus biflorus*.

In the sandier parts of this western tract the staff of life is derived from a rain crop of millet, which is sown as soon as a shower in July or August makes it worth while to give a hurried ploughing to the patches of soil which the inhabitants are pleased to call fields. Wheat is a garden crop confined to the small patches which it is possible to irrigate from wells. In the sands of Bikanir, water-melons occur spontaneously in such numbers as to form for some months in the year no small part of the food of the scanty population. The seeds of these and of other cucurbitaceous plants cultivated in gardens are ground, during times of scarcity, into a kind of flour.

From the preceding sketch it may readily be inferred that the country is barren and infertile, and it is difficult for one who has not visited it to realise that, in spite of its many natural drawbacks, it affords sustenance to a human population of exceptionally fine physique, and is the breeding ground of some of the finest races of cattle and horses and of the best camels in India. The bullocks of Nagore are celebrated for their size and paces; the endurance of the horses of Malláni is proverbial; while the swiftest riding-camels in India are born and bred in Bikanir. It is perfectly wonderful to see the apparently bare barren plains from which these animals contrive to pick up their daily food.

Nothing has hitherto been said of the cryptogamic vegetation of Rajputana. As might be expected, the richest spot in this respect is Aboo; but even there only about a dozen species of ferns occur, and of this small number only *Adiantum caudatum*, *Adiantum lunulatum*, *Cheilanthes farinosa*, *Nephrodium molle*, *Nephrodium cicutarium*, and *Actiniopteris radiata* can be said to be abundant. *Adiantum Capillus-Veneris* is found in a few spots, and *Botrychium virginianum* is very rare. Of mosses there are a few which, during the rains, form pretty tufts and festoons on the branches of the trees on the south-western slopes of the mountain, but at other times they are shrivelled and brown. There are a good many lichens on the trees and a few on the rocks. *Algæ* are not numerous. During the rains a good many *Fungi* spring up on decaying wood, and an edible *Agaricus* is found on grassy banks; *leaf fungi* are few in number.

In the eastern tract, the only ferns ever seen are *Adiantum lunulatum* and *caudatum*, *Nephrodium molle*, and *Actiniopteris radiata*. The latter is found only on walls, where it is associated with *Funaria hygrometrica*, the only moss at all common in the region. These species occur very sparingly, indeed, in the western tract, and only in shady crevices of rocks or on old moist walls. In wells, the maiden hair, *Adiantum Capillus-Veneris*, is occasionally met with on both sides of the Arvalis.

As has already been remarked, the province of Rajputana does not possess a flora peculiar to itself, but rather presents a field on which the adjacent floras of dry India and of the deserts of Western Asia and Northern Africa interosculate. In other words, there are, so far as the writer is aware, no species peculiar to this area, every plant in it being found also either in the adjacent provinces of Central India, Guzerat, the Punjab, North-Western Provinces, or in the dry regions of the Deccan and Southern India; while several of them occur also in countries far beyond the limits of the Indian Empire.

Extracts from the Report of the Royal Gardens at Kew for 1877. By Sir J. D. Hooker, K.C.S.I.

Boxwood.—For some years past the supply of this important wood has diminished in quantity and risen in price. It is derived from the forests of the Caucasus, Armenia and the Caspian shores. The wood of best quality comes from the Black Sea forests, and is principally shipped from the port of Poti. The produce of the Caspian forests, known in the trade as "Persian" wood until last year, was also exported through the Black Sea from Taganrog. This found its way after the commencement of the war, *viâ* the Volga Canal, to St. Petersburgh. The produce of the Caspian forests is softer and inferior in quality to that of the Black Sea. It is a matter of interest to see whether one result of the war will be to open those Black Sea forests which the Russian Government has hitherto kept rigorously closed. The falling-off of the supply has led meanwhile to various attempts to find substitutes for Boxwood for many purposes. Messrs. Joseph Gard-

ner and Son, of Liverpool, have introduced with some success Cornel (*Cornus florida*) and Persimmon (*Diospyros virginiana*) for shuttle-making, for which purpose hitherto Box has been in great demand.

Nan-mu Tree of Chinese.—Dr. Brandis has drawn our attention to a passage in Mr. Davenport's report on Yunnan [Parliamentary Papers, China, No. 2 (1877,) p. 13,] giving an account of the "Nan-mu" tree, the wood of which is so highly valued by the Chinese. If it could be accurately identified, the cultivation of the tree would no doubt be very profitable in India, and I, therefore, place on record what has been ascertained respecting it. The following is from Mr. Davenport's report:—

"This part of Yunnan (which seems to be between 25° and 26° N. lat.) produces the famous Nan-mu, so highly esteemed by the court for building purposes, and by the wealthy for coffins, on account of its durability. This timber is to be seen in perfect condition after the lapse of nearly three centuries in the shape of enormous pillars in the tombs of the emperors of the Ming dynasty, and has usually been supposed by foreigners to be Teak. The tree is tall, thin, straight growing, having no bough or twigs on the stem, but suddenly shooting out branches at the top, somewhat like a canopy over a maypole. Its bark is of a peculiar ashy grey colour, and a specimen of the leaves, gathered by myself, accompanying this report, will prove beyond all doubt that it is not a member of the Teak family.

During the Ming dynasty this wood had already become scarce (having probably been everywhere cut down and not re-planted), and was brought chiefly from almost inaccessible valleys inhabited by wild tribes. The imperial palaces at Pekin were built almost entirely of this timber.

At the present time this wood is imported into Shanghai in planks, measuring 8 feet long by 13 or 14 inches in diameter, for which the highest price is 200 dollars per plank. Whole coffins range from 100 dollars to 800 dollars.

The quality is judged of chiefly by the pungency of the scent. The leaves sent by Mr. Davenport to the Foreign Office cannot now be traced, but by the courtesy of E. Brad-

ford, Esq., late Master of the Apothecaries' Society, to which the specimens of drugs collected by Mr. Davenport were sent, I have been favoured with a further fragmentary specimen transmitted by Mr. Davenport, and also with specimens of the wood brought to this country by Wm. Lockhart, Esq., who states that "it is also used largely by Chinese gentlemen who take a pride in their libraries to make boxes for sets of volumes, and also to place between sets of volumes."

The leaves are too slender a basis for a certain botanical determination in the absence of flowers and fruits. But it appears extremely probable that the tree belongs to the family *Lauraceæ*, and the leaves themselves agree very closely with those of *Phœbe pallida*, Nees.

West Indian Forests.—Although scarcely falling within the province of this report, I cannot but record a word of warning as to the utter apparent absence of any restriction upon the destruction of the forests of the West Indian Islands, which must, as in some cases has already proved to be the cases, be injurious and even disastrous to those colonies.

With respect to Jamaica I extract, from a paper communicated to me by Mr. Thomson, the following particulars, which I think speak for themselves :—

"In certain localities hundreds of thousands of acres have been converted into desert by the wholesale destruction of the forests. In other localities hundreds of thousands of acres would, from the same cause, now be utterly unproductive, but for the interposition of foreign trees, [Logwood, Mango.]

"In consequence of the facility with which land is everywhere obtainable in Jamaica, the peasantry cut down annually 40,000 acres of forest land and thick bush on which to plant yams and other provisions. Innumerable timber trees, young and old, are thus yearly destroyed. These clearances are made in the most seasonable districts, and in many instances the excessive rainfall in such districts is perceptibly diminished in consequence of the large extent of these clearances. No conservation of the forest having ever been attempted here, the result is, as regards timber, that the resources of the island are practically nil. There is indeed some timber in the

inaccessible hills of the interior. Nearly all the timber required for building purposes is imported into the island, the annual value of which amounts to about 50,000*l*. Even the sleepers lately used for laying down the few miles of tramway in and near Kingston were imported. The unproductiveness of the island regarding timber is further to be deplored when our luxuriant tropical resources are borne in mind, and also when it is remembered that only one-thirtieth of the island is devoted to agricultural operations. In the event of any considerable advancement being made in the prosperity of the island, a very large expenditure would be entailed for the importation of timber."

The following extract from a letter received from Dr. Impray, equally seems to me to show the necessity of some forest supervision in that island :—

"*Pimenta acris*, (Black Cinnamon or Bois d' Inde), one of our most valuable timber trees, is being fast exterminated. We have no forest law, and the valuable timber trees of the island are cut down remorselessly, small and great, and of course none are re-planted. From the leaf of the *Pimenta acris* an essential oil is distilled, of which the far-famed (in America at least) Bay-rum is made. This perfume is used all over the United States. I believe there is almost a prohibitory duty on the oil, but it is smuggled into the country. Here the material will soon be exhausted, as the leaves are purchased at so much a hundred weight, and the negroes are cutting down all the young Black Cinnamon trees wherever they can get at them to secure the leaves.

Wood for Coffins in China.

It is well known that large sums are spent by the wealthy classes in China on certain rare and valuable kinds of wood for coffins. A considerable trade in woods for this purpose is being carried on, chiefly from Yunnan and other provinces of South China, northwards. Some time ago an English Missionary, travelling from Shanghai to Bhamo, met the Governor of a province on his way to Pekin, who was accompanied by strings of horses carrying planks of wood to give as presents to his

friends to make coffins. A collection of ten different kinds of woods used by the Chinese for coffins was lately sent to Kew by the Colonial Secretary for the Straits Settlements. All these woods were of the same good character, rather soft, very fragrant, and some with a fine silky grain. The prices are remarkable, ranging from a few pounds to £150. The extreme prices are almost fabulous; one case is reported of a coffin for a Mandarin, costing £600, and made entirely of wood.

One of the most valuable of these coffin woods is the Nan Mu, which grows in Yunnan, a tall tree with straight and clean stem, similar in general appearance to the wood oil trees of Burma. This tree has erroneously been identified with *Xylia dolabriformis*, the Pynkado of Burma. It probably, however, belongs to the family of Laurineæ.

The fragrant woods from Tavoy and Mergui, belonging to the genus *Cinnamomum* which were sent to the Paris Exhibition by Major Seaton, seem to be similar to some of the woods used for coffins by the Chinese, and they are again very similar to the Nepal Camphorwood, the Malligiri or Gunserai of Northern Bengal and Assam (*Cinnamomum glanduliferum*)—D. B.

On the Cinchona Plantation at Thantoungyee, B. Burma.

By the late Mr. S. Kurz.

Having visited last week the Cinchona plantation on Thantoungyee hill at your request, I have now the pleasure to submit to you the present memorandum.

From the few observations made with inferior instruments, the temperature appears low enough, although the place lies only about 3,800 feet above sea, to guarantee the growth of Cinchona at Thantoungyee. The atmosphere, however, will turn out to be too dry during the hot season. This is fully confirmed by the vegetation that covers these ridges. The forests there are evergreen forests, belonging to the variety, which I designated in my letter to the Conservator of Forests, British Burma, dated 29th May 1868, as Upper Dry Forests. They consist chiefly of *Schima Noronhæ* and *Sch. oblata*,

Myrica Nagi, *Albizzia stipulata*, *Helicia robusta*, *Quercus dealbata*, *Eurya japonica* and one or two other species, *Garcinia anomala*, an arboreous *Saurauja*, *Pyrenaria camelliæflora* in abundance, *Ternstroemia japonica*, *Anneslea monticola*, *Calophyllum spectabile*, *Pithecolobium sp.* (near *P. angulatum*) and another leguminous tree only found in leaf but very similar in habit to *Albizzia lucida*, *Dillenia aurea*, a probably new species of *Castanopsis* in great abundance, *Bischoffia javanica*, a large-sized bamboo called 'Kyellowa,' *Beilschmiedia*, *Turpinia nepalensis*, two arboreous species of *Araliaceæ*, *Podocarpus neriifolia* and a few other trees in less abundance. Along the choung appear a splendid *Livistona* and *Pandanus furcatus*, the latter in large number. Of creepers and climbers are especially seen—*Mucuna macrocarpa*, *Rubus rugosus*, a climbing berry-bearing bamboo, here called 'Wathabwot,' but different from the one so named in the Pegu Yomah, three or four species of *Vitis*, amongst them an *Ampelopsis*, a fine *Calamus* possibly new, with the leaves white underneath, *Smilax lanceifolia*, a *Bauhinia*, *Cnestis ignea*, *Lygodium polystachyum*, *Stenochlæna scandens*, etc. The undergrowth is chiefly composed of *Areca triandra*, *Melastoma malabathricum*, *Wallichia caryotoides*, *Maesa ramentacea*, a species of *Camellia*, *Tabernaemontana*, *Psychotria*, *Leea Staphylea* (?), a *Wendlandia*, etc. The herbage covering the dry ground is composed of *Strobilanthes Brandisii*, and locally of *St. pentstemonoides*, *Peliosanthes macrophylla*, *Tupistra nutans*, *Ophiopogon*, *Carex*, *Commelyna obliqua*, *Polygonum chinense*, a large *Phrynium*, *Alpinia nutans* and some other plants now without flowers or fruits, a species of *Pollinia* locally forming pasture grounds, *Dianella*, a large *Osbeckia*, *Molineria recurvata*, a fine large *Begonia*, *Lepidagathis*, and a number of ferns such as *Pteris aquilina*, *Aspidium*, *Nephrodium* and *Gymnogramme decurrens*. The stems of trees are but sparingly covered by mosses, but rich in cortical lichens, and, at my visit, were a good deal dried up, even as the *Hymenophylla*, *Xyris Wallichii*, *Asplenium laserpitiifolium*, *Niphobolus* and *Pleopeltis*, which are found frequently along with them. On granitic rocks, *Xyris Wallichii*, *Sonerila secunda* and *Didymocarpus mollis* are frequently seen. The ground is, during the hot season, densely

covered by dry leaves, &c., and jungle-fires enter these forests with as much facility as they enter the leaf-shedding forests of the lower regions. In fact, a large jungle-fire that broke out during my stay at the plantation, has shown me fully the destruction to which these forests are subjected during the hot season. The devastation by fire here is quite equal to that experienced in the plains, and where the large bamboo prevails even more fearful.

The soil is a light red soil, no doubt the result of decomposition of felspar of granitic rocks, with a great preponderance of rather coarse quartz-sand. The surface-soil is only to a very small depth, nowhere exceeding a foot, discoloured either by the decomposition of vegetable parts, or by the ashes of burnt-down vegetation. Huge rounded granitic rocks are seen here as everywhere in the Karen hills, striking out from the ground, or lying loosely on or along the ridges, or carried down to the choungs.

I should think that the locality was an excellent one for the cultivation of tea, and I am still more supported in my belief by the fact that nearly three-fifths of the forest trees forming these jungles are of the same family to which the tea-plant belongs, *viz.*, *Ternstræmiaceæ*. Besides, a species of *Camellia*, most probably identical with the Assam tea-plant, is found here plentifully along the Paloun, a choung which flows through the Cinchona plantation. But not a single kind of *Rubiaceous tree* was observed by me during my few hours' ramble through the surrounding forests.

The Cinchona will, no doubt, thrive here; but the question is, whether the cultivation at this place will really turn out remunerative. The trees will attain the same height and growth as the trees now composing these forests, that is, they will remain stunted and branched. Meanwhile, should they be planted along a choung in a deep alluvium, resting on primary rocks, it would cause the plants to grow up to be large-sized trees. It is for the latter reason that I should give preference to a formerly selected locality at Plumadoe, although I admit that the absolute elevation of Plumadoe valley is not sufficiently high (only about 2,200 feet). In my opinion, Cinchona would

thrive best in those forests, which I have mentioned in my letter to the Conservator of Forests above alluded to, as UPPER MOIST FORESTS, occupying the valleys and north and north-east faces of ridges, at elevations from 3 to 6,000 feet. The absolute height and depression of temperature caused by it are of little value, if not accompanied by a corresponding degree of dampness of the atmosphere. Nor is it absolutely necessary to go so high up the hills to obtain a temperature suitable for the cultivation of Cinchona. In fact, it is well known, and all my observations in Burma and elsewhere in India have taught me that valleys are much cooler and moister than ridges and summits of hills; so much so that, for instance, the temperature of Bogelay village at 3,000 feet elevation is more than 3 degrees higher than that of Palawa Zeik in Toukyeghat, hardly 500 feet above the sea. Unfortunately, there are no complete thermometrical observations at my disposal, either of Thantoungyee or of Plumadoe valley which could enable me to compare these two localities from a climatological point of view.

Dated Camp Otdweng, Toungoo, the 26th April 1871.

The function of the Pines and the Larch in the Production of soil.

(*Continued from page* 187.)

Of the three species of Pine which, in Europe, are found in cold climates—one, the *Pinus sylvestris*, is widely distributed; the other two, *P. montana* and *P. Cembro*, are very rare. The Larch is associated with these Pines either towards the pole or on lofty mountains.

The most important of the European Pines is, undoubtedly, the *P. sylvestris*, or 'Northern Pine,' known also by other names taken from the different localities in which it occurs, such as 'Auvergne, Briançon, Haguenau, Riga, Scotch or Norway Pine.' It is easily recognized from some distance by its ashy green-grey foliage, the colour of which is caused by the short light-coloured needles. The cones and the bark of the base of the stem have also a grey tint, but the higher portion of the bole,

and the point from whence the branches proceed, are distinguished by the characteristic bright red colour of the bark. This Pine is remarkable for the widespread area of its distribution. Found both in the plains and in the mountains, it advances from the extreme north of Europe to the southern regions, from the Icy Sea to the Mediterranean. On the Baltic Coast it forms, so to speak, one immense forest of 50 millions of hectares. As much again is found on the plateau of Central Russia, and the range of the tree extends thence beyond the Ural Mountains into Upper Siberia, so that it may be called the tree of the Northern deserts. In the valley of the Danube it is only met with in the mountains; in the Alps it is sometimes found at great elevations on southern exposures, owing to the protection afforded by the great mountain chain; in the Pyrenees it still forms forests at 1,500 metres, rising gradually thence to 1,800 metres, and extending itself westwards into the Basque region. Thus, passing from the north to the south of Europe, the elevation of the station of this Pine rises gradually, and seems in each region to be comprised between extreme altitudes of about 600 metres apart. Taken as a whole, the area of the home of the *Pinus sylvestris* presents the figure of a vast ellipse, having its centre in Russia, its greater axis passing between Moscow and Berlin, and its lesser axis extending from Lapland to the Black Sea. It is, however, restricted to poor soil, and especially to silicious sand.

In such a soil, the conditions of vegetation are difficult, and few forest trees can easily accommodate themselves. Unmixed with other species, the vast northern Pine forest, the 'bör' of the Russian plains, has a peculiar and wonderful appearance; the forest mass thin and with scattered trees is open on all sides to the light; and the soil, arid or peaty, only covered with dead pine needles, or with a carpet of bilberry and heather bushes and long thin erect-stalked grasses. Further south the Pines are mixed with Oak and Birch, the white bark of the latter forming a vivid contrast with the red boles of the Pines, and the brown oak trunks. In these forests animal life is scanty and silent, the presence of roedeer or the woodpecker here and there met with only serves to render the profound solitude more striking.

In mountain localities the Pine is often found in company with the Birch and the Silver Fir; these trees, by the thick cover they give, preserve the freshness of the soil, while the Pine, with its light foliage, overcovers them and thus forms trees of splendid form and magnificent bole.

The Scotch Fir requires abundant light for its growth. In the northern regions, where the summer nights are very short, it has full light almost without break during the season of vegetation; in the almost rainless plains of the Volga the dry pure air permits a strong light to reach the ground; and in the mountains of France it is found on southerly and westerly slopes, facing the Beech, the Silver Fir and the Larch, which usually cover those towards the north and east. Of all our forest trees, it is the one which best resists wind, provided it is not constant and cold, provided it is not damp.

In form the Scotch Fir varies exceedingly; it nevertheless is always *a tree* and never degenerates into a bush as do the Beech, Spruce, Birch and Mountain Pine. Even in Lapland, on the Tana, the most northern river of Europe, beyond the 70th parallel of latitude, it still forms trees capable in size of furnishing building timber, but still varies much in shape from the short, knotty, much branched and gnarled tree to the lofty mast-like straight growing Pine, whose summit ends in a narrow cone with only thin short branches.

Trees of this type, however, are always exceptional, even in suitable localities, and fine specimens over three centuries in age and capable of giving first-class mast timber are no longer seen. The type of tree, too, seems destined to disappear from the forest of Europe, where it formed such a magnificent spectacle of vegetable growth, but a few fine young trees of it are still to be seen in certain localities, such as in Italy and at Pustelnik in Galicia.

The best forests of *P. sylvestris* which France possessed were lost with Alsace-Lorraine. In the central plateau only a few still remain, such as are seen in the gorges of the Allier, although the mountains of Auvergne might easily be covered with them. A few fine trees may still be found in the Alps, but they are getting rarer and rarer every day in the forests of Provence,

Dauphiné and Savoy. In the Pyrenees the Scotch Fir is rarely found except as isolated trees; however, in the valley of Capsir, at an elevation of 1,540 metres, on the banks of the Aude where there is merely a small brook, surrounded by lofty mountain crests which shelter it on all sides, is an almost pure forest of Scotch Fir called the forest of Mattemal. In that station, on a platform of diluvium forming a terrace on the banks of the Aude, may be found trees of two hundred years of age, with a diameter of 0·65 centimetres, and stems capable of giving 17 metres of building timber. On this little plain, cut off from the plains of France by the still inaccessible gorges of the Aude, the trees have but very slight value, but great utility; the wood cannot be extracted, and without trees the country would be uninhabitable.

The *Pinus montana* is first found with the Scotch Fir in the forest of Mattemal in the Pyrenees, and it is also in that region found on the granitic slopes of Capsir, Roussillon and Cerdagne round Mont Louis. In the Alps, as in the Pyrenees, its home is at an elevation of 2,000 metres, but its elevation varies from 400 to 500 metres lower to the same amount of higher altitude, provided it is in favourable localities. It is not possible to mistake this Pine, whose bark is uniformly grey, from the Scotch Fir which has invariably some shade of red on the stem, or at any rate at the point whence the branches begin to spring, and merely from appearance there is no difficulty in distinguishing them, for the Mountain Pine is a tree of an aspect quite different from that of the Scotch Fir, being erect, pyramidal, with numerous close short branches, growing slowly, and rarely reaching any considerable size. In the Alps it is called *suffin*, and a tree of 40 to 50 centimetres in diameter is considered a fine specimen, though sometimes, as in the communal forest of Lian in Cerdagne, a larger size, and sometimes even double, is met with. Either above or below its proper locality this Pine degenerates and becomes deformed. On the uncongenial soil of torrential deposits on which the Mountain Pine is sometimes found at the bottom of valleys, it degenerates into a bush or rather a mass of thin closely-formed stems, and this is the form which has been called *Pinus Mugho*. At the upper limit of forest vegetation,

and especially on the northern slopes of the Swiss Alps, it is found growing prostrate or trailing over the ground, which in this way it shelters well enough, and from which circumstance it is called *zwergkiefer* or *legföhre,* the 'branching' or 'prostrate' Pine. Botanists have also called it 'Pin à Crochets' in consequence of a curious sport of the scales of the cone which are often curved back in the form of a hook. The cone of this Pine is also distinguished by its shining surface from that of the Scotch Fir which is grey and not polished.

The foliage of the Mountain Pine is also of a much darker green than that of the Scotch Fir, and this difference of tint permits us readily to distinguish from a considerable distance, often of several kilometres, the horizontal line which separates the two species in the same hill side where the Scotch Fir covers the lower, and the Mountain Pine the higher slopes, the latter usually higher than 1,700 metres. Besides the localities in France the Mountain Pine occurs also in some places in the Carpathian and Sudetian Hills, and in the Caucasus. As regards soil, it has no special predilection, as it may be found equally in limestone or sand, in dry soils or in marshy bogs, sometimes it appears, being then more or less of a botanical curiosity, accompanied by a few miserable stunted Birches, in the great masses of high regions, such as the Jura, the Vosges and the Black Forest, at a considerable distance from the original localities where its growth is abundant.

(*To be continued.*)

Wattle-Tree Cultivation.

A CORRESPONDENT, who a short time ago sent us his views on Tasmania as a place of settlement for Anglo-Indians, writes:—

"When on a visit to Kodi-Kanel, a few months ago, I was much struck at seeing how deeply-rooted the 'Wattle Tree' had become. The curse of this tree is well known, particularly in Tasmania, where one can see hundreds of acres of valuable cultivable land crowded with wattle, which nothing will kill, except dragging them up by the roots when they are young, care being taken that the root is not broken. The process of

grubbing up the young wattles is an expensive and tedious one. The earth round the roots must first be loosened by the use of a pick, then a horse or pair of bullocks are chained on to the butt-end of the tree, and drawn in the direction the root is growing. In this manner, roots 15 to 20 feet long, carrying on an average, a young tree to every foot of root, are dragged out without being broken.

"It may not be known by many, who are now doing their best to destroy the wattle, that the bark of that tree is most valuable for tanning purposes. When the discovery was first made some eight years ago in Tasmania, quite a rush was made in all parts of the country by speculators from Hobart Town and Launceston, who bought up all the wattle shrubs from the squatters, who were glad to sell the bark at five shillings an acre; and in the course of three years, the speculators were glad to buy the bark at £2 an acre. The process of stripping the trees simply requires a ring to be cut into the wood at the butt-end of the tree, when the bark is pulled off in strips by a number of boys, who are able to climb up the tree, so as not to break the strip, and also to strip the tops of the trees, where the best bark is to be found. The strips are tied in bundles by women, and stocked in certain small depôts by men, where the bark is left for some time to dry in the sun. It is then carted away in large six-horse waggons to either of the two towns, where it is crushed at the steam mills; and eventually a large quantity is shipped to England and the other colonies. At present the bark is worth as much as £5 a ton—so that it is not only a source of revenue to the farmer as long as he has trees to strip, but in another respect; the bark having become valuable, has been the cause of his being able to get his land cleared for little or nothing; because, as the stripped trees generally die, the contractors are made to cut them down; they are then heaped in large stocks, and when thoroughly dry are burnt; whereas, perhaps, for years, the farmer has seen his land gradually becoming a wattle scrub, the growth of which he was unable to cope with. In Victoria, in consequence of the cheap and abundant supply of wattle-bark, now acknowledged to be by far the most powerful tanning bark in the world, the export

in leather trade has within the last seven years largely increased. The exportation of hides has nearly ceased, while the number imported during the seven years were 392,228. The total value of leather exported during the seven years was £1,532,703, exclusive of the amount required for consumption in the colony. In 1870, the amount of bark exported was only 1,384 tons, representing £6,418, while in 1876 the exportations amounted to 9·724 tons, the aggregate value being £60,386. As the wattle tree grows very quickly, and seems to flourish so remarkably well at Ootacamund and Kodi-Kanel, it would be worth Government's while to try an experiment at plantation, on the formation of which the following few suggestions may be useful :—

"There are three species of wattle, namely *A. pycnantha*, commonly known as 'broad-leaf,' 'golden,' and 'green;' *A. decurrens*, or black wattle; and *A. dealbata*, or silver wattle. The bark of the first is superior to any other, but the tree is of slow growth, and does not attain such large dimensions as the black and silver species. For tanning purposes the silver wattle is generally discarded. The black wattle is of vigorous and robust habit, and for commercial purposes is equal to the broad-leaf species. September, October, November, and December ought to be the stripping season. In all cases 'stripping should be thorough, as the higher branches often carry the best bark, and under no circumstances should any bark be left on the tree.' The wattle requires little attention in cultivation. Its wood can be readily utilised for cask staves, axle spokes, axe and pick handles, and many other articles requiring a tough, durable grain, and when dried it is an excellent firewood. A good profit also may be derived from the sale of the gum which exudes from the trees which yield a percentage of tannin, but they can never replace the wattle. The bark from trees growing on a limestone formation is greatly inferior in tannin. One of the largest black wattles met with gave a mean diameter of 24in., its age being 18 years. The wattle is at its prime at 10 years. After that the tree loses its vigorous, healthy habit, and is usually attacked by disease or insects.

"Wattles grow on almost any soil, but their growth is most rapid on loose sandy patches, or where the surface has been broken for agricultural or other purposes. Where the soil is hard or firm, it is recommended that plough furrows should be made at regular distances of say 5ft. to 6ft. apart, into which the seeds are to be dropped. The outer covering of wattle seed is peculiarly tough, hard and horny in character, thereby forming a protection which renders the seed comparatively impervious to ordinary germinating influences. It will, therefore, be found necessary to employ a more direct agency than simply covering the seeds with earth. Water, of a little less than boiling temperature, should be poured on the seeds, and they may then be allowed to soak in the water until soft. As the seeds are small, and ought to be sown near the surface, a very light sprinkling of earth will suffice. It would be sufficient for all practical purposes of cultivation to drop the seeds at average distances of 1 foot apart along the furrows, in which case about 7,200 seeds would suffice for an acre of land. The wattle seed is, however, inexpensive, being obtainable in most districts for the mere trouble of collecting, or it can be purchased for 8*s.* or 10*s.* per lb. There are about 40,000 seeds of the *Acacia decurrens*, or black wattle, to the lb., while the seeds of the *Acacia pycnantha*, or golden wattle, are one-fourth heavier, and consequently represent not more than 30,000 to the lb. The seeds can, therefore, be dropped along the furrows at much shorter distances, and the seedlings thinned out at discretion, whereby the chances of a regular plantation would be increased. On loose, sandy soil, on which *Acacia pycnantha* can best be raised, it might not be even necessary to break up the soil in any way; but it should be borne in mind that any opening up of the surface would materially accelerate the germination of the seed and subsequent growth of the seedlings. On such open sandy soil the straight furrow line may be dispensed with and the seeds scattered broadcast. When the young trees have attained the height of three or four feet, the lower branches should be pruned off, and every effort afterwards made to keep the stems straight and clear, in order to facilitate stripping, and induce

an increase in the yield of bark. In all instances where attention is paid to the cultivation of wattles as a source of income, care should be taken to replace every tree stripped by successional sowings, in order that there should be as little variation in the yield as possible."—*From the 'Madras Mail,' October* 18, 1878.

The Forests of Cyprus.

From "Gardeners' Chronicle" of July 27th, 1878.)

As already stated, some writers who profess to write for the public information have imagined forests of Pine, Beech, &c. Unfortunately forests of any kind of tree are exceedingly limited in area, and chiefly confined to the inaccessible parts of the mountain chains; and as for the Beech, there is no record, we believe, of its ever having been found in the island.

Formerly, it is true, Cyprus was covered with forests, and was noted for its excellent timber; but according to Unger and Kotschy there is no doubt that then, as now, the forests consisted principally of Pine trees. From the sea-level up to 4,000 feet *Pinus maritima* prevails, and above that altitude it is replaced by *P. Laricio var. Pairetiana*. Even now it is possible to trace the earlier distribution of these two Pines, and see that the Pine forests were only interrupted here and there by other trees. Although the work of devastation has been carried on very recklessly, there still exist some beautiful though thin forests of *P. maritima*. *Europhaca boetica* flourishes only in the shade of this Pine, and *Quercus alnifolia*, *Arbutus*, *Andrachne*, and *Acer creticum* are often associated with it as underwood, sometimes straying beyond and forming independent copses. The forests of *P. Laricio* are nobler and undisturbed, because they are in less accessible situations. This Pine clothes the heights of Troodos, Adelphos, and Machera, and these alone. Few flowering plants flourish underneath the Pines. One of the most conspicuous is the beautiful *Pæonia corallina*, and *Limodorum abortivum* pushes forth from the decaying bed of Pine foliage. *Juniperus fœtidissima* is associated with the Pine on and near the summit of Troodos, to which also *Berberis cretica* penetrates. Only the

two species of Pine named occur in the island. *Cupressus horizontalis* and *Juniperus phœnicea* are rapidly disappearing as forest trees, though the latter spreads as a shrub where the maritime Pine makes room for it. *Quercus inermis* and *Q. Pfæffingeri var. cypria*, the only arborescent species of Oak, are now quite rare as trees, and can never have had any considerable distribution in the island. *Platanus orientalis* and *Alnus orientalis* exist only by the side of the beds of streams; and *Cratægus Aronia* and *Pistacia palæstina* are rapidly disappearing, fine specimens being quite rare. The general character of the flora is quite Mediterranean, as distinguished from Syrian. One of the most noteworthy features in this is the prevalence of needle-leaved trees in Cyprus, whereas in Syria these are re-placed by flat-leaved trees. A considerable proportion (4·2 per cent.) of the species are peculiar to the island, at least they have hitherto not been found elsewhere. Of these, eleven are *monocots* and thirty-one *dicots*—two *apetalæ*, sixteen *gamopetalæ*, and thirteen *polypetalæ*. Amongst the most noteworthy are *Quercus alnifolia*, which represents *Q. Ilex; Q. cypria, Ballota, integrifolia*, a spiny species; *Pterocephalus cyprius, Salvia cypria, Galium suberosum, Ornithogalum pedicellare, Silene lævigata, Gladiolus triphyllus, Colchicum Troodi, Crocus cyprius, C. veneris, &c.* The bulb flora, it may be repeated, is still very imperfectly known.

Bamboo as a Paper-making Material.

TO THE EDITOR OF THE "INDIAN FORESTER."

DEAR SIR,—I have only just received your Journal for April, and perceive you have kindly inserted therein my letter on Mr. Smythies' experiments on Bamboo in the Central Provinces. From fortuitous circumstances, due mainly to Bamboo being a tropical product and failing supply, I regret to say I have been unable to progress much further in experimenting on its manufacture into "Paper Stock," the long-continued commercial depression being deterrent on any new enterprise in India. I am, however, daily looking for an arrival

of some thousands of stems collected for me by Government in Burma to be crushed at Rangoon by the rolls I sent out, and also some few tons from Jamaica collected for me by Mr. Robert Thomson, the author of the letters I inserted in the Society of Arts' Journals of January and March last.* I mail you herewith, and you will confer a favor if, to keep this important subject alive and promote discussion and attention, you will insert their letters in your next issue.

Mr. Thomson is again in England, and his further investigations more strongly confirm the conclusions therein referred to: placing the cheap and continuous supply of this valuable paper-making material beyond dispute, and as I venture also to add that my experiments so far have proved its value as regards quality for the purpose, I hope ere long to find the subject will acquire the importance in our great Indian Dependency which I think it merits. In the persent somewhat hazy condition of European politics, not merely speaking selfishly, but in the interests of our English Paper Trade, I think it will be admitted it would be better we should draw our supplies of raw material from India than be dependent as now almost entirely on Esparto grass, the quality of which I may add is getting less and less reliable.

That judiciously and economically carried out the manufacture of paper stock from Bamboo will pay, and pay well, I confidently assert.

I will not fail to send you samples of the paper and paper stock from the Bamboos now in transit to our works so soon as they arrive, and remain meanwhile,

Dear Sir,
Faithfully yours,
THOS. ROUTLEDGE.

CLAXHEUGH SUNDERLAND,
17*th October* 1878.

* The first addressed to Sir Joseph Hooker, the second to Mr. Routledge.

CINCHONA PLANTATIONS, JAMAICA;
6th November 1877.

DEAR SIR JOSEPH,—I have thought of writing you for some time on the subject of your remarks, in your last annual report on Kew-gardens, on bamboo as a material for paper-making. I hope you will excuse the liberty I now take in submitting the views I entertain on this subject. I have taken much interest in this matter, and have been in communication for some time with the largest firm of paper exporters in America, with the object of establishing the export of the raw material from here on a large scale. I have also from time to time, in my reports to the Government, referred to bamboo as being one of the most important paper-making materials. And I may further mention that both the *European Mail* and the *Planter's Gazette* have recently noted the encouraging prospects that exist in Jamaica of establishing a large export trade in bamboo.

Cutting the bamboo stems *en masse*, as you have stated, would undoubtedly destroy the plants; but, with great deference, I would remark that this destruction of the plants can be effectually prevented by the adoption of a different process of cropping. Thus, instead of cutting all the stems simultaneously, a given proportion of matured stems should be retained, and this need only be a small proportion, sufficient to maintain the vigorous action of the roots. The stems thus retained for the preservation of the fructions of the roots may even be moderate in size. Indeed, they may be lopped so as to superinduce the sprouting of branches and foliage near the ground. Another point to be observed consist in the manner in which the young, succulent stems are cut. They should be cut—that is, the crop for making paper—not close to the ground, but a few nodes above the ground should be left. This plan ensures the sprouting of branches and foliage from some thus left, and maintains the unimpaired action of the roots.

The continuity of supply of the bamboo by the adoption of this plan aggregated to a very considerable quantity each year; and, as has been seen, a bamboo plantation may be kept up indefinitely in regard to time.

I have seen three tons of full-grown stems obtained from a bamboo clump, covering only a few square yards. This would be an enormous quantity per acre. By the system of cropping which I propose, each succulent stem, in that condition in which a penknife is easily passed through it, when dried averages only about three pounds in weight. As many thousands of these are obtainable per acre annually, I feel sure that some ten tons of paper stock could be procured from each acre annually; putting it even at the half of this, the cultivation would prove highly remunerative.

The system of reserving a due proportion of growing stems, by which systematic thinnings would be constantly obtainable, is so obviously advantageous, that I think it would entirely supersede the plan proposed by you, namely, growing bamboo like the sugar cane, and to replant after cutting the crop. Bamboo cuttings, though they root immediately, require to be planted a long time, certainly over two years, before they produce large and vigorous stems suitable for paper making.

It is a pity that some method could not be devised for utilising the ripe bamboo stems in paper manufacture. Some years ago hundreds of tons of the ripe stems were exported from here to America, which stems, I have been informed on reliable authority, were made into paper; this trade was brought to a close owing to some difficulties in the monetary affairs of the merchant in New York to whom the bamboo was consigned. An almost incredible quantity of ripe bamboo is procurable from each acre of land, and I find that the ripe bamboo is used in China for paper manufacture. In a most interesting "Catalogue of the Chinese Imperial Maritime Customs," collection of products at the Philadelphia Exhibition, published by the authority of the Inspector-General of Chinese Maritime Customs, the following account is given of the process of treating the bamboo stems:—"The method of preparation from bamboo is as follows: The bamboo is stript of its leaves and split into lengths of three or four feet, which are packed in bundles and placed in large water tanks; each layer of bamboo is then covered with a layer of lime, water is poured on till the topmost layer is covered. After remaining in this

condition three or four months, the bamboo becomes quite rotten, when it is pounded into pulp in a mortar, cleansed and mixed with clean water. This liquid is poured in quantities sufficient for the size and thickness of the sheets required, upon square sieve-like moulds. These sheets (of which a skilful workman can make six in a minute) are allowed to dry, then taken from the mould and placed against a moderately-heated wall, and, finally, exposed to the sun to dry. The best quality is made from the shoots of the bamboo, with alum added to the infusion; the second from the bamboo itself, though a higher grade of this quality is attained by the previous removal of the green portion."

I would add that the prices of paper made from the bamboo in China range from 3 dols. 61 cents. to 21 dols. per *pecul* (133⅓ lbs.).

I remain,
Dear Sir Joseph,
Yours truly,
ROBERT THOMSON.

To SIR JOSEPH HOOKER, F.R.S.,
Director, Royal Botanical Gardens,
Kew.

DEAR SIR,—With reference to your letter of 30th December last, addressed to me in Jamaica, and which I only received a few days ago, it having been returned to me here from Jamaica, I beg to submit my further views on bamboo cultivation.

Jamaica has a very striking variety of climates in the lowlands more or less suitable for bamboo growth. This variety of climates has been caused by the improvident destruction of the forest. Bamboo on the drier plains presents a shrivelled and stinted aspect, except when within reach of water, which ensures its wonted luxuriance, it therefore assumes its greatest luxuriance in the most humid districts. Many hundreds of acres of certain districts are densely covered; for instance, a certain part of the parish of St. Thomas is literally covered with it. The plant flowers and yields seed in Jamaica under

very exceptional circumstances, so that seeds are rarely seen. I have never been fortunate enough to see it in flower. It has been widely distributed owing to the readiness with which cuttings grow in most climates. The ripe stems are commonly used to form fences, the post and rails consisting of the stems; the posts, if placed in the ground prior to the rainy season, take root, and unless they are frequently trimmed become irrepressible thickets. Ripe stems of medium size are not uncommonly used by the Negroes as poles on which to support each plant of Yam, which climbs over the pole in their cultivated "provision grounds;" these stems in like manner grow. This will explain the facility with which the plant is propagated—though it is likewise propagable by offsets or rhizomes, I think, however, the stem process of propagation would be in every respect preferable.

With regard to the question as to the period required to produce "crops by planting," I am quite sure that this period could not be diminished by planting offsets from established stools. It should be remembered that by any system of propagation of the bamboo, the first process of rooting is very simple; the result of the first roots is the production of slender, twiggy shoots, but as these latter become matured, the increased vigour of the root action creates stems with proportionately increased strength, and so on step by step until the fully developed stems are producible; the whole length of time, from the time of planting, as I have already mentioned, for the maturation of the crop being at least two years.

An individual stool, if influenced only by the ordinary rainy seasons, I think would not produce more than one crop in a season, but under a system of irrigation I am strongly inclined to believe that two crops would be producible. For the wants of the paper manufacturer it will no doubt be supposed that the available command of bamboo obtainable may be turned to account, instead of having resort to the formation of plantations. I will, however, briefly endeavour to show that a regular plantation possesses immense advantages. The existing bamboo, though only a few miles from shipping ports, is not so conveniently situated as it would be in a special plan-

tation, on which the most advantageous and accessible spots would be set apart and systematically planted in a series of plots, in order to facilitate and economise cutting and carriage. The advantages thus indicated would be considerable, but the great advantage of planting bamboo would be that of having it brought under the influence of irrigation, as it is peculiarly a water-loving plant.

It is well known that general crops of bamboo shoots are only produced after heavy rains, a fall of from 15 to 30 inches; such rains usually occur two or three times a year in Jamaica; the time young shoots take to spring from the ground up to about 25 feet (they are at this height in a fit condition for your requirements) after such rains averages five weeks. Irrigation would produce constant action at the roots, and there can be no doubt that by the process of cutting, which I advocate (*vide* my letter of the 6th Nov.), several crops a year may be secured; indeed, a continuous succession of cropping could be assured by systematic cultivation and irrigation.

To those who have not visited the tropics it is impossible to conceive the extraordinary luxuriance of this gigantic grass. The description you give in your valuable pamphlet is far short of its majestic grandeur.

In laying out a plantation, I think that cuttings should be set about four or five feet apart; thus by planting thickly the intervening surface would be expeditiously occupied by the stools, and this system ensures the benefit of fostering among the plants a reciprocal tendency to shoot upwards.

The cost of planting would be about £2 per acre. After planting, four or five weedings, costing ten shillings, would be given during the two years required to establish the plantation. Subsequently to this cultivation would be absolutely dispensed with, except the application of water and a judicious system of cutting out the stems.

The Government of Jamaica has constructed, at great expense, magnificent irrigation works on the St. Catherine Plain, surrounding Spanish Town, and as very little advantage has been taken of this precious adjunct to tropical agriculture, land is obtainable at a very cheap rate, and it is most conve-

niently situated, as the railway connects it with Kingston, only 15 miles distant.

The irrigation works are constructed to irrigate upwards of 14,000 acres, but only a few hundred acres of cultivation have actually been brought under the influence of this water. Labour would be abundantly obtainable at 1*s.* 6*d.* a day; hundreds of strong Negro labourers would be at command all the year round, and for rough and continuous hard work the Negro is far superior to the coolie, and they prefer any kind of work to sugar estates work.

The Government undertake to supply a quantity of water (as I mentioned in a previous letter to you) equivalent to a rainfall of 60 inches a year for £1 per acre per annum; this is very moderate, as it would certainly double or treble the crops of bamboo annually as compared with the ordinary seasons. The average rainfall of the locality in this irrigation scheme is about 40 inches.

Our bamboo is *Bambusa vulgaris*, but, of course, you are aware that all the varieties are most productive in localities in which moisture is most abundant. This is a most important consideration, in view of the production of bamboo in Jamaica, and one which has, perhaps, not received any attention; the variety of climate as regards moisture is very remarkable. The destruction of the forest in most parts has materially lessened the rainfall; certain districts are too dry for bamboo to exist in, others only afford sufficient moisture to maintain the bamboo in a condition of very partial luxuriance; it therefore follows that districts having a constant precipitation of rain, with a normal average of from 80 to 100 inches a year, are best adapted for this plant. Astonishing crops under irrigation, therefore, would be obtainable at a small cost of production, for it would require little or no cultivation beyond its first establishment.

I agree with you that it would not answer to export the bamboo in any other way than manufactured into paper stock, not only on account of the great difference in the cost of transport, but owing to the deterioration of the article in tran-

sit, when it is sent in a crude state, due to the difficulty in drying the young stems, even after crushing.

I may mention, that before your pamphlet was published I was impressed with the notion that bamboo was destined to become the most valuable of all materials for paper-making, by reason of the quantity of it producible per acre—a quantity of fibre far greater than can be produced from any other plant, a fact to which you have referred. It should be remembered that bamboo grows its whole height in a few months, that the great bulk of it is composed of fibre which is convertible into paper stock, and that it produces its stems so closely, that is to say, each stem about 60 feet high (*Bambusa vulgaris*) occupies about half a square foot. Thus it does not require, as you state at page 8 of your pamphlet, two feet; half a dozen at least grow within two feet. Indeed, I should scarcely like to say what quantity of bamboo may be realised per acre, but it may be safely predicted that it will be so large that it will revolutionise the paper trade.—Remaining yours truly,

ROBERT THOMSON.

11, QUEEN-SQUARE, BLOOMSBURY, LONDON,
22nd February 1878.

Utilization of Salei Wood for Sleepers.

(*From Indore Forest Report in the "Indian Agriculturist" of May* 1878, *p.* 170.)

Mr. Carey, the Chief Engineer of the State, reports:—

"*Forests.*—Since last year the jungles of the Bai districts have been added to my care; much fuel, teak bullies and logs for shoring up foundations of bridges have been supplied to the railways.

"Large quantities of bullies are being supplied to the Military Department, Indore, and to numerous village people for building their houses and for farming purposes.

"*Sleepers.*—Experiments have been and are being tried on railway sleepers; in February last year, six Salei sleepers were cut green and immersed in a tank (made expressly for the purpose) filled with Behera leaves and water; in the June following these sleepers were put down on the Neemuch State Railway, and are to this day as sound as the day they were put down. This wood was always considered next to useless, as being so readily attacked by insects, but five months' soaking in a solution of Behera leaves, whose tanning properties are well-known, has proved that sleepers can be obtained from this tree. We have vast quantities of Salei in our jungles, well grown, capable of making on an average quite 8 half-round sleepers from each tree; of course, time will test the life of these five sleepers; at present they look most healthy and promising, and if they turn out long-lived, we are safe to find a market on the

two lines of Holkar and Neemuch State Railways, and thereby make a good revenue.

"One hundred Salei sleepers were cut in June 1876, and laid in the Kanar river and left during this monsoon with the intention that all impurities should be soaked out in the running water; after the rains only, 49 sleepers were found; the rest had been washed away; these have been laid down on the Holkar State Railway by the kind permission of the Engineers; on trial they appear sound, but the action of weather and being constantly run over by trains will soon test their worth. We could supply Unjan sleepers, but they are worth more to us at the Indore market as logs than being cut up into sleepers; the rate for sleepers being rather at a low price."

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The Banda Forests.

(By G. Greig, Esq., Conservator of Forests, Central Circle, N. W. P., dated February 23rd, 1878.)

The Bánda forests are confined to the three southern pargánas of Badausa, Tirohan, and Thán, the bulk of them being in Tirohan; they contain a variety of trees and shrubs (see appendix A.), and they are situated on low rocky hills of the Bundelkhand type: the top a plateau (pátha), the sides precipitous walls of rock (ári) from 50 to 300 feet high, and then a more or less gradual slope to the valleys.

The plateaux are, as a rule, fairly level, but some are undulating and on some are distinct little hills; most of them are totally uncultivated, but on a few there are villages: for instance, Panwari, Lakhanpur, Kulmar Parasin, Chaori, and Rajowan. With the exception of Kulmar Parasin, these are small poor villages, inhabited principally by Gonds and Kolis, who live in temporary hovels with thatched roofs, and have a constant struggle with nature, in the shape of poor soil, pigs, monkeys, and nilgái, to save sufficient of their wretched crops to keep themselves from starvation. These plateaux are generally fairly well covered with dawa, shéj, sándan (or tinsa), khair, saj, tendu, achar, salie, &c.

The precipices flanking the plateaux are very extraordinary and picturesque; the huge blocks of rock piled one above the other in all sorts of grotesque shapes and positions give them the appearance of enormous masonry fortifications in

ruins; various kinds of ficus grow along the tops of the "ari," their roots shooting through crevices of the rocks and hanging down the face of the precipices like so many ropes. The base of the "ari," being cool and moist, is generally well clothed with fine trees of many kinds and a few bamboos, with here and there dense thickets of the large-leaved creepers, mahwál and badrasin, climbing over huge masses of fallen rock, and forming quiet retreats for a few sambar and an occasional tiger after their nightly rambles. The only places I observed the reoni (*Mallotus phillippinensis*) were in cool moist spots at the foot of the "ari."

The slopes are almost invariably successions of terraces and slopes sparsely covered with inferior forests of khair, katber, dawa, &c., which are much injured by lopping for cattle and goats; lower down in the basins the forest improves, and the valleys are generally well covered with all the most useful kinds of timber trees.

As may be seen by the map, the railway from Allahabad to Jubbulpore runs right through the main portion of the forests. About 13 or 14 years ago, an enormous amount of wood was used in the construction of this line; the forests within ten miles or more of the line appear to have been clean swept of every tree except mahua, and although a coppice of about ten feet high has since sprung up, it is easy to see how the forest has deteriorated. Fires have destroyed many of the stools of the better kinds of trees, their places being now occupied by the hardy katber and jarber (*Zizyphus xylopyra* and *Jujuba*), and those that remain alive have been so injured that their shoots are thin and sickly-looking.

And this is what is still going on, more or less, in all but the more distant and inaccessible parts. A great deal of firewood is bought by contractors for brick-burning, &c., in Allahabad; building timber is cut anywhere and everywhere it is required; cowherds and goat-herds all carry axes and ruthlessly hack down trees right and left; and then come the annual fires, which either kill the stools entirely, or so injure and weaken them that only a small proportion of their coppice shoots grow into useful timber.

Under such treatment it is not surprising that the forests deteriorate; by the end of summer all leaves and other vegetable matters have been burnt, and the ground left perfectly bare and as hard as a brick. The monsoon breaks with a heavy downpour; it takes many days to soften the ground sufficiently to allow the rain to soak in as fast as it falls, and meanwhile the water is rushing off the hills in torrents, and carrying with it immense quantities of surface soil to the rivers below.

Slowly, but surely, does this go on year by year, and if some precautionary measures are not taken, the whole of these forests must disappear; the hills will become as barren as those about Morar and in parts of Jhansi, and then it will be almost *impossible to re-clothe them.*

As may be gathered from what has been already written, the first point to be attended to towards preventing the denudation of these hills is to put a stop to jungle fires; that is absolutely essential, and without it no improvement can be expected. Keep fires out of these forests for the next fifteen years, and the whole aspect of the country will be perfectly changed: the trees and grass will remain green until well on into summer; a thick coating of vegetable mould will be formed, which will keep the ground cool and moist; the rain will then percolate through the soil instead of rushing off in torrents and carrying soil with it; the temperature of the neighbourhood will be lowered, and dry watercourses will become running springs of pure spring water. This is a pleasant prospect compared to the other, but it is not, I think, exaggerated.

At the time of the last settlement, the advantages of forests were evidently not appreciated; they were treated as so much waste land, and were divided off amongst the neighbouring villages, to be used by the people without restriction according to their own lights. The results of this are now very apparent, and as that settlement has expired, and Government is now at liberty to do as it pleases, this is the very time to step in and prevent ruin.

The revenue survey map of 1840-41 of the Banda district is so utterly inaccurate regarding the waste lands that it is

impossible to compute the area; but the Collector estimates it at about 250 square miles, about 150 of which might be "closed to the people without serious inconvenience to their agricultural or pastoral wants."

Although it is impossible to say positively what that profit will be, I am inclined to think that, after a few years of proper management, not less than Rs. 8,000 to Rs. 10,000 a year may be expected; and, as the quality of the timber improves and the trade increases, the profit would, of course, increase also. As far as I could learn, the annual exports now amount to some 64,000 maunds of firewood (say 30,000 by rail and the remainder to local marts) and about the same quantity of building timber. If the small royalty of (say) half an anna per maund on firewood and one anna on timber was enforced, this alone would amount to Rs. 6,000; and besides this, there would be a certain revenue from wood supplied to villagers who have no forest rights, and from bamboos and other minor produce.

The mahua is the finest and most valuable tree in the district; it seems to thrive on the very poorest soil, and magnificent specimens are to be seen all over the country, but more especially near villages. The natives protect the mahua very carefully, and never allow a tree to be felled: its flowers form a staple article of food (and drink).

The most valuable timber trees are those mentioned in paras. 13 and 17; there are others—such as teak, dhaman, bija sál, &c.—which are of more individual intrinsic value, but they are so scarce that they are hardly worthy of notice. Those that I have classed "the most valuable" do not grow into large trees, as we find them along the foot of the Himalayas, but they grow straight and clean, and furnish excellent poles of from 6 to 15 feet in length.

Names of trees and shrubs.

Bánda vernacular name.	Sub-Himalayan, North-West Provinces' name.	Botanical name.	Remarks.
Tendu (ebony)	Tendu	Diospyros Melanoxylon ...	Fruit much eaten.
Sale	Not found	Boswellia thurifera ...	Yields a fragrant gum, used as incense in India, but not the olibanum of Europe.
Dháman	Dháman	Grewia vestita	
Khair	Khair	Acacia Catechu	Wood yields catechu.
Jáman	Jáman	Eugenia Jambolana ...	Scarce; a useful timber; fruit edible.
Aonla	Aonla	Phyllanthus Emblica ...	Excellent wood; fruit edible.
Renja	Not found	Acacia leucophlœa	Bark and seed edible.
Dubein	Ditto	Dalbergia paniculata	
Dhawa	Bakli	Anogeissus latifolia ...	Very plentiful; excellent building timber.
Sagon (teak)	Not found	Tectona grandis	Very scarce.
Báns (bamboo)	Báns	Dendrocalamus strictus ...	Not very plentiful.
Mahua	Mahua	Bassia latifolia	The finest tree in the district; the flowers are much eaten by men and animals, and are distilled into common country spirit.
Mahwál	Máljan	Bauhinia Vahlii	The elephant creeper.
Bél (bael)	Bél	Ægle Marmelos	Excellent wood; the fruit is an excellent medicine for dysentery.
Semal (cotton tree) ...	Semal	Bombax malabaricum ...	Not plentiful.
Palás	Dhák	Butea frondosa	Yields "Bengal kino."
Pilu	Khumbi	Careya arborea	Bark used for ropes and matchlock fuses.
Karaunda	Karaunda	Carissa Carandas	Common; fruit makes a good preserve.
Bahér...	Bahéra	Terminalia bellerica... ...	Wood inferior.
Gúlar	Gúlar	Ficus glomerata	Woods used in wells; durable under water.
Shísham	Sissu	Dalbergia Sissoo	Very scarce.

Banda vernacular name.	Sub-Himalayan, North-West Provinces' name.	Botanical name.	Remarks.
Imli (tamarind) ...	Imli	Tamarindus indica	Not common.
Sirsa	Sirras	Albizzia Lebbek	Not common.
Tinsa or Sándan ...	Sándan	Ougeinia dalbergioides ...	Fairly common; excellent wood.
Jamrassi or Mamri ...	Not known	Elœodendron Roxburghii ...	An excellent timber and fairly plentiful.
Jamalgota	Ditto	Croton Tiglium	Very scarce; yields the croton oil of commerce.
Anjan	Not found	Hardwickia binata	A fine tree; scarce.
Achar or Chironji ...	Katbhilawa	Buchanania latifolia ...	Fruit much prized.
Haldu	Haldu	Nauclea cordifolia	A large tree; not very plentiful; yields good usefu. timber.
Kaim	Kaim	Nauclea parviflora	Very similar to the above.
Bija Sál	Bija Sál	Pterocarpus Marsupium ...	Very scarce; excellent timber.
Kusam	Gosam	Schleichera trijuga	Useful for sugar and oil-mills.
Kowa	Anjani	Terminalia Arjuna	
Sáj	Sein	Terminalia tomentosa ...	Fairly plentiful; excellent timber.
Gotaha	Katber	Zizyphus xylopyra	Fruit used as a black dye for leather; leaves much liked by cattle.
Bér	Bér	Zizyphus Jujuba	Fruit forms a staple article of food; leaves and fruit much liked by animals; an exceedingly useful bush.
Shéj	Dhaura	Lagerströmia parviflora ...	Excellent timber and plentiful.
Seina	Amaltás	Cassia Fistula	Good timber, but scarce.
Páper	Pápai	Pongamia glabra	A large tree; wood inferior.
Katyya	Not found	Not known	Of no special use.
Dudhi	Dudhi	Wrightia tomentosa ...	A fine grained wood; used in turning.
Gabdi	Kumbi	Cochlospermum Gossypium ...	Of no special use; wood soft and light.
Karhár	Thanella	Gardenia turgida	Common, but does not grow to any size.
Kulu	Not found	Sterculia urens	Wood soft and light.
Gurja	Kharpat	Garuga pinnata	Yields the gum "katíla;" not valued.

Bairi	Chilla	Casearia tomentosa	Wood not valued.
Bhoti	Pátha	Kydia calycina	Wood close and straight grained ; not common.
Not known	Pádal	Stereospermum suaveolens ...	Not common.
Ditto	Reoni	Mallotus phillippinensis ...	Yields "kamela" powder ; very scarce.
Not known	Mainphal	Randia dumetorum ...	Fruit used to poison fish ; not plentiful.
Ditto	Marorphal	Helicteres Isora	A small shrub ; bark yields a strong fibre.
Ditto	Dhaulchak	Erythrina suberosa	Wood used for scabbards, &c. ; not plentiful.
Ditto	Khairwál	Bauhinia purpurea	Scarce.
Gánt	Gandla	Murraya Königii	Leaves used for flavouring curries.
Badrásin	Not found	Not known	A larged-leaved creeper.
Kápúr	Ditto	Ficus	Common along the precipices.
Kinni	Ditto	Ficus	A fine handsome tree, found occasionally near water-courses.
Dántul	Ditto		

The Rate of Growth of Sal.

Extract from pp. 35, 36 of the "Manual of Indian Timbers."

THE wood of the Sál tree has concentric rings, which we at present assume to correspond to one year's growth. There are a few cases on record in which the wood of young trees (up to 15 years) has been found to have a number of rings corresponding to the age of the tree. But sufficient proof to support the assumption has not yet been collected. Assuming, however, that the concentric rings are annual, the following information is available regarding the rate of growth of Sál :—

In 1873, Mr. Fisher examined 40 Sál trees in the Pantan Reserve, Kamrúp district, Assam: 5 trees of 6 feet in girth had, on an average, 10 rings per inch of radius; 20 trees of 4 feet 6 inches girth had an average of 9·7 rings per inch; and 15 trees of 3 feet girth had 11 rings per inch. The rings were counted on lengths of radius, from the centre, of 2·86, 5·73, 8·6 and 11·5 inches respectively, corresponding to a girth of wood only of 18, 36, 54 and 72 inches.

In 1874 he examined 32 trees in the Balipara Reserve, Darrang district, Assam: 10 trees of 1 foot 6 inches girth gave an average of 38 rings, or 13 rings per inch of radius; 10 trees of 3 feet girth gave 61 rings, or 10·6 rings per inch of radius; 10 trees of 4 feet 6 inches girth gave 92 rings, or 10·7 rings per inch; 1 tree of 5 feet 7 inches girth gave 110 rings, or 10·3 rings per inch; and 1 tree of 6 feet girth gave 122 rings, or 10·6 rings per inch of radius.

In 1875 he examined 20 trees in the Sidli forests, Goálpara district, Assam: 8 trees of 4 feet 6 inches girth gave an average of 89 rings, or 10·3 rings per inch of radius; and 17 trees of 3 feet girth gave 50 rings, or 8·8 rings per inch of radius. The rings were counted in the same manner as in 1873.

In 1876 he examined 11 trees in the same forests: 4 trees of 4 feet 6 inches girth gave 76 rings, or 8·8 rings per inch of radius; 7 trees of 3 feet girth gave 51 rings, or 8·8 rings per inch.

In 1877 he examined 17 trees in the same forests: 1 tree 6 feet in girth gave 103 rings, or 9 rings per inch of radius;

1 tree 4 feet 6 inches in girth gave 96 rings, or 11 rings per inch of radius; 13 trees of 3 feet in girth gave 51·5 rings, or 8·9 rings per inch of radius; and 2 trees of 1 foot 6 inches girth gave 26 rings, or 9·1 rings, per inch.

The rings were counted in the same manner in each case. The result of the detailed counting of the rings was as follows:—

Locality.	Number of trees.	Rings counted on a length of radius from centre, corresponding to a girth (wood only) of			
		18″	36″	54″	72″
Pantan (on the hill)	22	30	56	82	115
„ (in the plains)	18	32	65	96	126
Balipara	32	38	61	92	116
Sidli, 1875	20	28	52	69	...
„ 1876	11	26	51	76	...
„ 1877	17	26	51	72	90
	120	30	56	83	113

On an average the number of rings per inch of radius is 10, and it will be noticed that the annual increments are exceedingly uniform. A tree grows:—

up to 18 inches girth (wood only) in 30 years.
from 18 to 36 „ „ „ in 26 „
„ 36 to 54 „ „ „ in 27 „
„ 54 to 72 „ „ „ in 29 „

In the Oudh forests a different result has been obtained. When the first proposals were made in 1863 to regulate the working of the forests of the Kheri division, the following was assumed as the mean rate of growth:—

Girth 18 inches, age 15 years.
„ 54 „ „ 50 „
„ 72 „ „ 80 „

Subsequent data seeming to indicate a somewhat slower rate, it was estimated in 1868, in order to settle the number of trees to be cut over in 1868 and 1869, that a girth of 54 inches would be attained in 65 years, and a girth of 72 inches in 95 years.

In September 1869, Mr. Forrest examined 50 logs cut in the Newal Khar sub-division of the Kheri forests; these logs had a mean girth of 5 feet 3 inches, and gave on an average 4·79 rings per inch of radius. Again in 1877 a Sál tree, about 16 or 17 years old, was examined by Captain Wood, and at 1 foot from the base, where the girth was 1 foot 10 inches, it was found that an inch of radius contained 4·80 rings. Thus, supposing we take 5 rings to the inch as indicating the average rate of growth, the trees examined in Oudh would have attained a girth of 6 feet in 57 years, which, it will be seen, is about one-half the time which the trees examined by Mr. Fisher in the Dúars required to attain the same size.

In the Central Provinces the counting of rings has given a mean between Bengal and Oudh. In 1867, Captain Douglas examined 13 stumps in the Bijeragogarh forests; their mean girth at 17 inches from the ground was 5 feet 3 inches, and the average number of rings per inch of radius was 6·5. In 1874, Mr. Fernandez examined a single stump in the same forests, and 7·2 rings were counted per inch of radius. The mean of the results of these countings is 6·85 rings per inch, which would place the age of a tree 6 feet in girth at 78 years. Subsequent observations in the Banjar Valley forest, Mandla district, give a mean of 5 to 8 rings per inch, and tend to confirm this rate of growth.

The following cultivated trees of known age were measured by Mr. Brandis in 1863:

Saharanpur, and Eastern Jumna Canal 13 years, girth 27 inches (average of 33 trees).

Ditto ditto 30 years, girth 54½ inches.

Ditto ditto 35 years, girth 79½ inches.

Calcutta 25 years, girth 69 inches (one tree).

NOTE.—We have printed this as a continuation of the Memo. on Teak, by Dr. Brandis, published in our last number; and in the hope that our readers will oblige us with any further data that they may possess.—*Editor.*

The Eucalyptus and its industrial application.

The Indian reader may almost be weary of papers on *Eucalyptus*. We have had many; some of them good, some of them indifferent, some of them exaggerated and incredible; nevertheless the subject is one of real importance, so that no really valuable contribution to its literature ought to be overlooked. And the paper which follows is an abstract of a paper written by M. Felix Martin, a French engineer, in the *Annales des Ponts et Chaussées* for October 1877, and is certainly an important contribution to our knowledge.

It contains so much that is of little use in India that I determined to present an abstract rather than a complete translation.

The difficulty in France is to find a species robust enough to stand cold. With us the want is a species that will stand heat and drought. And the difficulty is to get *accurately*-named species.

It is now perfectly well known that while *E. globulus* succeeds in the middle ranges (as regards elevation) of our Himalaya, it will not grow in the plains. It is also known that *E. resinifera* grows freely in the plains as a rule.

What other species really succeed is still doubtful.

Hence the extreme importance of very carefully keeping the *names* of the species.

It is unfortunately too common to read in reports of District and Canal Arboriculture, that "the *Eucalyptus* sown this year succeeded," and so forth. All the while it is not said which of the 160 species is meant! Should any one kind really show good growth, we have no means of identifying it for further cultivation, and can only wait till a specimen flowers, when it can with certainty be identified.

In this way *E. tereticornis* has been identified as succeeding well at Abbottabad, and no doubt at other places, not actually in the hills, but still raised above the plains and the great heat which they have to bear.

B. H. B.-P.

Although the *Eucalyptus* has been cultivated in Algeria on the large scale with complete success, its cultivation in France

has hardly extended beyond plantations for ornament. Numerous memoirs have been published with the object of attracting the attention of agriculturists and foresters, but as yet no one has thought seriously of making the attempt to derive the profit which the growth of this species on the large scale would secure.* It is, indeed, now more than fifteen years that the species was first planted on the Mediterranean littoral, still the stage of experiment has not been accomplished, and it is now time to go further, at least in giving those experiments a wider scope. M. Martin has already made a considerable number of plantations in Provence, and is thus able to offer the results of his experience, especially in its bearing on the utility of the species to the engineer.

Until lately the attempts in France were limited to the introduction of the one species, *E. globulus*, but this species does not quite present the necessary hardy qualities. This again has given rise to the idea that *Eucalyptus* culture must always remain a speciality of Algeria, of Corsica, and of that part of the littoral which corresponds to the region of the orange tree. In that case the subject would have only a limited interest.

We must, however, take into account the resources which a process of acclimatization has at command, and also remember that some of the species are less sensitive to cold.†

The term 'acclimatization' has been criticized on the ground that it is not possible so to vary the natural qualities of a species, as to make it take kindly to a climate different to that in which it grows naturally.

It is true, indeed, that we cannot modify the essential nature of a vegetable species, fixed in the soil and exposed passively to the effects of the weather, in the same manner as we can that of animals by judicious selection and breeding between individuals of exceptional hardiness whose qualities may thus be developed and become hereditary. On the other hand, it is a fact of experience that the continued action of a lower temperature, rendering less rapid the move-

* M. Martin adds that the English—a practical people—have called the tree, "The Diamond of the Forest."

† With us, of course, the problem is to get species, in themselves valuable, which are not sensitive to *heat*.—B. P.

ment of the sap and retarding the vegetative power at critical seasons, may in time render the tissues better able to resist cold. So that plants, if they cannot exactly be *acclimatized*, may at least be *naturalized*. This process may also be aided in the way of natural selection, by the creation of local varieties from successive sowings. Plants grown from the seed of *E. globulus* originally imported from Africa and established at Mentone and Nice, have at Marseilles resisted a cold of −6° centigrade (= 23° F.) These were hardier than plants grown directly from Australian seed which could hardly bear a temperature of −4°. The *Eucalyptus* has certainly acquired the stamp of a naturalized tree in fulfilling the condition that it can spontaneously reproduce itself, by successive seedling growths.

But the genus *Eucalyptus* contains more than 160 species, of which about two-thirds have been tried either in Algeria or in Provence, and within such wide limits as can obtain species which will resist a cold of −10° and even −12°.

Engineers have special opportunities for encouraging the introduction of these species and making them generally known by using them for railway and road-side avenues, and plantations to which they are exceptionally well adapted.

When it is recollected that in France there is a demand for about 4 millions of sleepers annually, and that the demand for wood far exceeds the supply, it cannot be doubted that the acquisition of a species which exceeds in rapidity of growth any indigenous tree, is in itself an advantage almost incalculable.

The *Eucalyptus globulus* was first noticed in 1792, by the botanist Labillardière; he called it *globulus*, from the form of the seed capsules. It was not till 1854, M. Ramel, a Frenchman travelling in Australia, procured some seed, which was sown at Paris in the spring, and had reached a height of about 12 feet in the same year. In 1861 the species was introduced at Algiers, now it may be counted by millions, and other species also were cultivated.

Even in France, a good deal of progress has been made. The whole region between Cannes and Monaco is full of *Eucalyptus*, among the olives, and the *Pinaster* pines. It resists well the violent winds of those localities.

The *Eucalyptus* belongs to the *Myrtaceæ*: all the species have persistent leaves and are more or less odoriferous. They possess a remarkable faculty of absorption. A branch of *Eucalyptus*, freshly cut and weighing 800 grammes and plunged in a vessel containing 48 litres of water, was weighed in the evening and found to be 825 *grammes*, having absorbed in 10 hours, 2·392 grammes (about 32 grains) of water, after allowing for the normal evaporation from the vessel.*

The tree grows naturally in the valleys and moist slopes of wooded mountains from the Gulf of Apollo Bay to beyond Cape Wilson, and thence in occasional groups as far as the Buffalo Range. According to Labillardière it reaches to the colder elevations of the southern parts of Tasmania. Change of climate does not appear to diminish its natural rapidity of growth. In the garden of Hamma, near Algiers, M. HARDI has seen plants attain 18 feet in one season. Both in Algeria and in Provence there are specimens of 35 metres (about 120 feet) high, and there is nothing to lead us to doubt that they may attain to the height of 100 metres (330 feet) observed in some cases in Australia.

It is not surprising that with such marvellous rapidity of growth as a fact, a certain amount of exaggeration has crept into popular accounts. But the following are actual measurements: —

Locality.	Known age.		Height.	Circumference at 1 metre from the ground.
	Yrs.	Months.	Metres.	Metres.
Nice Railway Station† ...	12	10	19·50	1·42
Ditto	11	2	14·00	1·20
On the line from Marseilles to Vintimille near Vence-Gagnes‡...	8	0	8·0	0·50
Level Crossing of the Var ...	7	9	11·0	0·63
Ditto of La Roya near Vintimille..	4	10	8·50	0·37
Railway Station of St. Raphael ...	3	11	6·50	0·30
Slope of the cutting on line to Fréjus	3	11	7·0	0·33

* In the original it is 2·392 with *k.* for "kiln." This must be a mistake.—B. P.

† Both species have been lopped three times, otherwise they would have reached 30 metres.

‡ All the plants were from 40 to 50 millimetres (2 to 2½ inches) high when planted out, and this corresponds to an age of 10 months which is added under the head of total age.

A tree in a garden at St. Raphael, planted in well-worked and manured siliceous soil, *i.e.*, grown with garden cultivation, attained in two years nine months a height of 8·50 metres.

Unfortunately the introduction of the other species of *Eucalyptus* has been too recent to make it possible to give data for comparison of their growth with that of the blue gum. This rapidity of growth is strangely united with hardness in the wood. This hardness increases sensibly with exposure to the air, and is supposed to be, to some extent, accounted for by the coagulation of gum-resins in the woody tissue. These substances are contained in special cells distributed through the wood; they are exceedingly abundant in some species.

It is not, however, to be supposed that hard and strong timber is yielded by any but *mature* trees.

Time must be given for the central concentric layers to lose their porosity by the force of the pressure caused by the growth of the outer layers; and M. MARTIN would put fifteen years as the least age at which such a result could be expected. Experiments made with acclimatized specimens, which of necessity have not reached this age, of course give rise to mistakes and to disappointment.

In Australia excellent building timber, masts for shipping, and sleepers for railways are furnished by this species; but there, trees can be brought from the forest, which for a hundred years and more have been hardening their timber.

It is said that the blue gum will not grow in the company of other trees. This appears to be true. M. CORDIER noticed that when he filled up blanks in a plantation of Conifers with *Eucalyptus* (the plants in the group being 6 feet apart and between 5 and 6 feet high) the Eucalyptus grew, but with greater difficulty than elsewhere.

M. LAMBERT observed that the *Eucalyptus* roots seek a soil which is light at the surface, and that the roots of Conifers being more accustomed to strike downwards did not interfere with the gum roots to the same extent as other shrubs or plants with superficial roots would.

To this perhaps is due the fact that a forest of blue

gum has no undergrowth. It is not due to the fact that the tree only gives a very slight shade. This quality is not without its use, as herbaceous plants only can come up under a cover of gum tree, and so forest pasturage may be obtained without the risk of fire, which always exists where there is a growth of brushwood.

It was also supposed for a long time that the blue gum required siliceous soil, and would not grow on calcareous. It was compared to the Cork-oak, which exhibits such an aversion to the latter that the growth abruptly ceases on reaching it, and thus marks clearly the geological change. But this comparison is by no means true; the blue gum prospers on both soils. All that is wanted is a light and permeable soil; even sand is not unfavorable. The species might possibly be used for planting on the 'dunes.'*

Opinions differ as to the best method of treating the species in plantations—some desiring to attain greater hardiness by letting the plants do without much culture from the very first; either sow the seed *in situ*, or at least put out the plants, where they are destined to remain, while mere seedlings. Others again object to this method, and never plant out the gum tree till it has a completely-formed woody stem.

It would seem, on the whole, that the former plan is better where the soil is good and the conditions of climate not extreme, and the latter where there is a poor soil and an extreme climate.

In Algeria, the sowings are made in September and October; in France, in March and April.

The blue gum in its first youth has a quadrangular stem, which becomes cylindrical as the tree grows up.†

It would seem that the planting out should not be made before the stem commences to grow round, for the younger stems are much more sensitive to cold.

Transplanting is best done in France in April, when the

* We have not found that *E. resinifera* exhibits a dislike to growing with other trees which it soon out-tops. Both this species and others we believe to be *E. rostrata* and *E. marginata*, have tap, or descending roots for some 16 or 17 feet at least.

† The curious change of leaf is also familiar to many readers. The young plants has opposite and sessile leaves, after which they change to *alternate*, with *long leaf-stalks*, and of a different *(falcate)* shape.

vegetation is still retarded owing to the low temperature, but when there is no danger from frost.

In hot dry climates, like the north of Africa, August seems a good month; then the sap is in repose at the close of the long drought of summer more completely than it is in Europe in winter. It profits next by the comparative coolness of September and by the rains of the autumn, while the winter is not cold enough to stop the growth. This season seems very much to resemble the spring of Australia itself.

The *Eucalyptus*, it has been well established, cannot be reproduced by cuttings (*boutures*), nor by layers, and it does not send up root-suckers.

It seems to improve in facility of bearing removal, &c., as it gets acclimatized. It is said that in Portugal, where *E. globulus* is extensively grown, young plants are taken up and moved without earth about their roots, and that for considerable distances, and in a very hot summer.

The species coppices from the stem with great vigor. Some three-year old plants, about 20 feet high, planted along one of the public roads in France in 1866, were broken by a storm of the "mistral" (north-west) wind. They were cut down to the ground, and next year showed a perfect crown of shoots more than 6 feet long.

This valuable property of reproduction is of great *value* in countries where forest fires are feared. Even if burned, the tree would quickly recover by coppicing. It is not, however, known up to what age the species retain this power.*

M. Martin has next a series of remarks on the *value* of *Eucalyptus* plantations, which are not applicable in India.

But the following may be given for comparison :—

One hectare (2½ acres) is supposed to be planted or sown; the trees being 1·80 metres (about 5 feet) apart, giving 3,025 trees to begin with :—

* M. Martin recommends *E. globulus* for planting along the edges of fire lines, and thinks it would oppose especially the action of burning fir cones, which are always so much dreaded in spreading a fire among conifers. He does not, however, give credit to any special non-inflammability of the species; and I am rather inclined to doubt the utility of the species in this respect. The resinous leaves are very inflammable.—B. P.

	Francs.
1*st.*—Thinning at three years old 1,210 stems, worth ... ... (leaves trees at 3·60m. apart, or double original distance.)	1,210
2*nd.*—Thinning at six years old 514 stems, worth (leaves trees at 7·20m. apart.)	2,570
3*rd.*—Thinning at nine years 231 stems, worth (leaving 231 trees at 14 metres apart,) valued at	6,930
Total value in nine years ...	17,640

Another valuation beginning with 1,000 trees to the hectare gives :—

	Francs.
1*st.*—Thinning at five years 500, worth ...	600
2*nd.*—Ditto at ten years 250, worth ...	1,313
3*rd.*—Ditto at fifteen years 125, worth ...	1,473
4*th.*—Ditto at twenty years 60, worth ...	1,521
5*th.*—Ditto at twenty-six years 60, worth ...	3,195
Total ...	8,102

The bark is shed like that of the plane-tree, and is very valuable from the large quantity of tannin which it contains. Analysis shows 12 to 15 per cent., which is nearly double the yield of the bark of *Q. Ilex*, which sells at 14 francs for 100 kilogrammes.

The leaves and twigs of the blue gum yield on distillation an essence which is an excellent solvent for copal, camphor, mastic, &c. These essential oils also burn with a white flame without smell or smoke. They have begun to be used in perfumery also.

An infusion made by treating the leaves with alcohol is said to yield a liquor which may supplant the deleterious 'absinthe' so much in vogue. Its medicinal value is also great. In Algeria many fever patients have given up quinine in favor of the decoction of *Eucalyptus*.

M. MARTIN assures us that the therapeutic value of the infusion has been thoroughly tested in France, and alludes to a

work by Dr. Gimbert (Paris, 1875) on the subject, quoting an observed case of cure of a chronic malarious fever acquired on the banks of the Danube. Quinine had been continually taken without effect, and the fever was at last treated with doses amounting to 20 drops of the alcoholic infusion daily.

The leaves being thus valuable, the loppings and prunings on the railway from Marseilles to Vintimille, sell for 25 to 30 francs for 100 kilog.

The value of acclimatized seed cannot be overrated; it produces far more useful plants than freshly imported seed. In order to be fully ripe the seed has to remain on the tree for two years, counting from the date of flowering.

M. MARTIN has sold to the Italian Government seed grown between Nice and Mentone, at a price of 300 francs per kilog. The more general cultivation will of course lower the price, but this is only to be desired. Every part of this tree is, therefore, of value.

M. MARTIN then turns to the uses which an engineer will put the *Eucalyptus* to, on the various roads and other works he wishes to plant. For roads and the slopes of embankments and cuttings the species is to be highly recommended, as the leaves are persistent, and thus superior to the plane, for instance, the leaves of which fall early do not easily disintegrate and choke small drain pipes, &c. The facility of growth by coppice renders it valuable for planting on embankments which have to be *consolidated*. Here the trees are cut back so as to have a mass of shoots.

Eight thousand blue gums have been planted between Marseilles and Vintimille, along the railways. In Algeria this practice has been adopted universally, and every railway may be dated by noting the age of the trees.

A section is next devoted to the value of the blue gum in rendering healthy swamps and malarious localities.

The author believes this to have been definitely established. Certainly several localities in Algeria afford very striking instance on the subject, and recent experiences in France are still more remarkable.

It is, however, little use discussing the subject in detail in

India, because it is quite certain that the blue gum will not grow at all in the plains of Northern India; and in the middle slopes of the Himalaya, where it flourishes, there is comparatively little of such work to be done.

It is said that the disinfecting and health-giving effects of *Eucalyptus* are not confined to the species *globulus*, but to *rostrata*, *marginata*, *resinifera* and *obliqua*.

It is unfortunate that of these *resinifera* alone is a certain success in the plains. We have recently had *rostrata* seed, and it is now hoped that we may be really sure of the species. We have succeeded remarkably well with trees *called obliqua*, but have no certainty that the species is really this.

We have still, however, to ascertain whether some species will not take readily, and without excessive care and cultivation to the plains. And the difficulty has been, that neither has the name of the species been preserved, nor, it must be confessed, has the nomenclature of seed received from Australia been uniform or reliable. We are only now beginning to get *correct names* for the trees, as one after the other succeeds and produces flowers or fruit which can be sent to Kew for identification.

The species vary in size from a shrub to a giant tree; they occur in definite geographical and climatic distribution, and it is perfectly certain that some species which will flourish in the higher hills or to the centre and east of the Himalaya, will not bear the climate of the more westerly hills, on the same range, at the same elevation: that some species will suit our sub-montane and intra-montane valleys (*e.g.*, *E. tereticornis* in Abbotabad), while others will flourish in the plains.

The ascertainment of *species* accurately is the present pressing need of Indian *Eucalyptus* experiments.

As regards the planting of dunes and littoral sands, the genus is partial to well-divided and siliceous soils; but the blue gum is sensitive to sea-air, and can, therefore, only be employed at a suitable distance inland.

A species called "black butt" (*E. persicifolia*) answers perfectly in resisting the sea-air. It has a red fine-grained wood. This is a species found in Gippsland.

As regards the uses of *Eucalyptus* timber, M. Martin has already given a useful caution about expecting much from trees which, however surprising the dimensions attained in a few years, cannot be expected to have had time to harden and consolidate their timber.

Sleepers of trees of 8 and 10 years old, cut at Antibes in the garden of M. Thuret, were put down on the Marseilles Railway in 1872, and gave results inferior to birch.

At Algiers, indeed, M. Trottier exhibited in 1876 telegraph posts, which had been in use for three years, but they were impregnated (*injecté*—what with is not stated). M. Martin says that we have made in India a very interesting experiment, and have succeeded in doing away with the danger which arises to sleepers, beams of bridges, &c., from white ants, by employing the "Járra" or Australian Mahogany (*E. marginata*) as sleepers. I rather think that an experiment *was* tried; and, though the white ants did not attack the sleepers, still the wood split, and otherwise failed to satisfy the authorities. We have heard no more for some years of the import of *Eucalyptus* sleepers.

E. marginata has only very recently been introduced into Algeria, and tried in France.

The value of some of the species in resisting the action of water, and of the *teredo*, &c., is well known.

The size of timber obtained is quite in keeping with its adaptation to ship-building and other works requiring timber of large dimensions.

In 1851, M. Raveret Watel states there was a plank sent to London not less than 47 metres (about 154 feet), 3·50 metres (nearly 12 feet) broad, and 8 centimetres (nearly 4 inches) thick.

A plank of 51 metres (nearly 170 feet) had been prepared at Hobart Town for the Exposition of 1855, but no ship could be found able to take it in. Instead of this a specimen was sent, consisting of a section of another tree. This section was over 8 feet in diameter (more than 10 feet girth) when cut at a length of nearly 200 feet above the root! The whole of this tree, which yielded a perfectly fabulous number of

planks, small beams, and other pieces of all sorts and sizes, realized in all £245-12, or over 2,000 rupees for the one tree!

The paper concludes with a chapter on species most suited for introduction into France.

In Algeria, the *E. globulus* succeeds in a great variety of climate. On the coast, the air is temperate and moist; in the interior, dry and hot. At Constantine, the ancient capital of Numidia, on a plateau of 640 metres elevation, the heat of the vertical sun is great, nevertheless there is both rain and snow.

The mean temperature is 17° (centigrade = 62° F.); various other places show temperatures of 16°, 20° and 12° (60°, 68° 53° F.) In all these climates *E. globulus* succeeds, but it will not stand (*e.g.*, at Laghouat in Algeria) the sirocco winds.

The species *E. Gunii*, his failed in France.

E. coriacea is a temperate species growing up to 5,000 feet in Tasmania.

E. punctata is noted for the elasticity of its wood.

E. colossea (diversicolor) has succeeded wonderfully in Algiers, and seems to be unusually handy.

E. robusta, called "swamp mahogany," is not successful.

E. calophylla has *large, shade-giving leaves*, and is specially recommended; it comes from Western Australia.

E. coccifera has been noted as particularly well, resisting severe cold and violent winds.

The 'Argan' Tree of Marocco (*Argania Sideroxylon*)

This large, gregarious tree, peculiar to Marocco, has only lately been brought to notice. In their "Journal of a tour in Marocco and the great Atlas," Sir Joseph Hooker and Dr. Ball thus describe it:—

"The Argan tree is in many respects the most remarkable plant of South Marocco, and it attracts the more attention as it is the only tree that commonly attains a large size, and forms a conspicuous feature of the landscape in the low country near the coast. In structure and propertie it is nearly allied

to the tropical genus *Sideroxylon* (Iron-wood), but there is enough of general resemblance, both in its mode of growth and its economic uses to the familiar olive tree of the Mediterranean region to make it the local representative of that plant. Its home is the sub-littoral zone of South-Western Marocco, where it is common between the rivers Tensift and Sous. A few scattered trees only are said to be found north of the Tensift; but it seems to be not unfrequent in the hilly district between the Sous and the river Oued Noun, making the total length of its area about 200 miles. Extending from near the coast for a distance of thirty or forty miles inland, it is absolutely unknown elsewhere in the world. The trunk always divides at a height of eight or ten feet from the ground, and sends out numerous spreading nearly horizontal branches. The growth is apparently very slow, and the trees that attain a girth of twelve or fifteen feet are probably of great antiquity. The minor branches and young shoots are beset with stiff thick spines, and the leaves are like those of the olive in shape, but of a fuller green, somewhat paler on the under side. Unlike the olive, the wood is of extreme hardness, and seemingly indestructible by insects, as we saw no example of a hollow trunk. The fruit, much like a large olive in appearance, but varying much in size and shape, is greedily devoured by goats, sheep, camels and cows, but refused by horses and mules; its hard kernel furnishes the oil which replaces that of the olive in the cookery of South Marocco, and is so unpleasant to the unaccustomed palate of Europeans."

Consul Drummond Hay, writing from Mogador, on the 28th February 1878, mentions it in his report on the Trade and Commerce of Mogador for 1877, in the following extract, to which is added the correspondence between him and Dr. G. Birdwood on the subject of the 'Argan' tree and the possibility of its introduction into India: —

Extract from Consul Drummond Hay's Report, dated February 28th, 1878.

Considerable damage was done to the crops of 1877 by the locusts, whose appearance in this part of the country was mentioned in my report for 1876; but, as their devastating flight

was limited only to a certain line of country, many provinces escaped the scourge. The prospects for the harvest of 1878 are at present very unsatisfactory.

Since the first rains in September, only three inches of rain have fallen in Mogador, and, it is reported, still less in Soos and the country lying between this port and Morocco. Cattle in the interior are starving for want of grass, and can be bought in the market for the value of their skins. In the neighbouring provinces of Haha and Shiedma the drought will be less felt, as they are thickly wooded, and the forests of Argan trees above all afford nourishment, both for the natives and their flocks, in times of scarcity.

This remarkable tree grows only in those provinces and Soos, and is utilized in the following ways:—In the first place, the peasants extract an oil from the nut, which is useful both for burning and cooking purposes. When the nuts ripen and fall off the trees, they are collected by the natives, who are aided in the harvest by their goats. These animals swallow the fruit for the rind, but, being unable to digest the nut, they throw it up again, and it is then added by their owners to the store for making the oil.

For their private consumption, the peasants rarely make a large quantity of oil at a time, but crack open a few handfuls of nuts with a stone; and, after toasting the kernels in an earthenware dish, grind them into flour. The oil is extracted by adding water in small quantities to the flour, which is stirred in a bowl. As the oil is being formed by this process, the flour hardens into a cake, which is finally squeezed, leaving the oil perfectly clear and fit for use. This kind of oil cakes then serves as an excellent food for cattle, as also the dry rind of the nut, which is generally given to them with the cake, forming together their principal and most nutritious food during the year, and proving invaluable to the natives in time of drought, for the Argan tree is very hardy, and a dry year has little, if any, effect upon it.

Even the empty husk of the nut, when broken, is not thrown away by the peasant, but used as fuel. The best charcoal is made from the Argan tree, and the dry timber

is excellent firewood. The goats feed also upon the leaves of the tree, and when browsing in the Argan Forest may be seen climbing amongst the trees, plucking and nibbling the nuts and leaves.

Memorandum by Dr. G. Birdwood, C.S.I., dated August 30th, 1878.

I had already made enquiries about the Argan tree, and have learned from Professor T. Dyer that it is the *Argania Sideroxylon* of botanists, one of the *Sapotaceæ*, an order to which many well-known Indian trees, both naturalized and indigenous, belong.

The indigenous species in Bombay are *Chrysophyllum Roxburghii*, "tursiphul;" *Sapota tomentosa*, "Koombul;" *Isonandra Candolleana*, a tree of the same genus as the Guttapercha tree; *Bassia latifolia*, the celebrated Mowah, from the flowers of which Mowah spirit is distilled, and from the seeds of which a large quantity of oil is obtained, used for making soap in the Kaira Zillah, and the wood of which is used for the naves of wheels; *Mimusops Elengi*, "Buckool;" and *Mimusops hexandra*, "Kurnee," the tough close-grained wood of which is used for making sugar mills.

The introduced species are—*Chrysophyllum pomiformæ*, from Jamaica; *Mocarphus edulis* from Otaheite; *Kauki* from the Moluccas; and *Achras Sapota*, the Sapota plum of South America, which has become thoroughly naturalised in Western India, and yields a fine dessert fruit, the size and shape of a guinea, covered with a rich brown rough rind, very sweet to the taste, and containing two or three large smooth chestnut-coloured seeds yielding oil.

There is every likelihood, therefore, of the Argan tree succeeding in India. In what localities it would succeed best it would be difficult to say beforehand with any certainty. Marocco consists of the southern slopes of the Atlas range, which stretches in a curve from Cape Gher on the Atlantic to Cape Deir, opposite to Gibraltar, and falls from an elevation of 16,000 feet to the low lands in a succession of terraces exposed to the full influence of the north-west wind, laden with the

moisture it has gathered for more than a thousand leagues in its way across the North Atlantic Ocean. The natural heat of the country lying so near the Tropic of Cancer is, therefore, tempered both by the rain-clouds, which hang over it from October to February, and during the spring and summer months by the south wind which comes over the snow, which lies perpetually on the summits of the minor range of the Atlas mountains, producing one of the most agreeable and fruitful climates in the world. The littoral vegetation is that of the Mediterranean generally. The olive, laurel, citron, almond and fig, and the myrtle, cyprus, oleander, white poplar and aloe, grow everywhere; while the minor uplands (slopes and valleys) are covered with dense forests of tropical trees. Taking these physical facts into consideration, the cosmopolitan character of the order, and the fact that innumerable African plants, both Mediterranean and tropical, have become completely naturalized in India, it is probable that the Argan tree also will flourish in India everywhere, but most in sub-Alpine tracts exposed to the sea breeze and an annual rainfall of from 50 to 25 inches.

It would be most useful of course to encourage its growth in districts exposed to draughts.

It will be observed, however, that it is very similar in its economic properties to the Mowah tree and Sapota plum. The Mowah is one of the noblest native forest trees of India, and is plentiful everywhere in Western India, at least in the Concans, on the Ghâts, in Gujerat, and Rajwara, and if more of a tree like the Argan is wanted in India, it would probably be more profitable to encourage the extended cultivation of the indigenous Mowah, than to squander money and time in the attempt, which might after all prove vain, to introduce a new and imperfectly-known exotic.

Extract from a Despatch from R. Drummond Hay, Her Majesty's Consul at Mogador, dated Mogador, 1st November 1878.

The season here for sowing the Argan nut is during the winter months; it does not take longer to sprout than a melon

seed. The tree is quite indigenous to this part of Marocco, growing only in the hilly districts lying south of the River Tensift (near to Suffee), and I am informed that all endeavours to cultivate the tree in any other part of the country have failed. The soil in which the tree thrives is composed chiefly of limestone and sand. It will grow in very rocky and strong ground, but I have noticed that the finest and most fruitful trees are those which grow in cultivated ground.

Samples of the oil-cake and dry rind of the nut upon which cattle are fed might interest persons desirous of cultivating the tree, and I should have no difficulty in procuring and forwarding them if required.

Report by Dr. G. Birdwood, C.S.I., dated 1st December 1878.

I have examined these seeds. They are in prime condition, and if forwarded to India forthwith by the outgoing mail, will arrive at the most favourable time for sowing them, at least in Bombay. They should be sent in the bag in which they have come, laid in a strong deal box. Copies of all the papers relating to them should be sent with them for the guidance of those to whom the rearing of the trees will be entrusted. I would venture also to suggest that they should be addressed to Bombay, from where they would be most conveniently distributed to the rest of India.

Substitutes for Boxwood.

The following extract from the "Asian" will be read with interest. With regard to a substitute for Boxwood, we should be glad to know whether the wood of *Gardenia latifolia*, Aiton, has ever been practically tried for engraving. It is hard, smooth, even and close-grained, and not liable to split; and in case it should be found to succeed, a large supply might be obtained from the Central Provinces, where it grows on the most rocky soil, and has at present little or no value.

S.

"More than half a century ago, Dr Wallich, then Superintendent of the Calcutta Botanic Gardens, sent home, we believe to the Society of

Arts, specimens of a large assortment of Indian woods, several of which attracted attention, but nothing more came of it. We had not then an organized forest conservancy department. This department, as we learn from the English papers, has recently despatched—not samples—but a consignment of logs of woods, the produce of our Indian forests. These logs are of irregular shape, some of very large size, and varied so far as quality is concerned, for structural or manufacturing purposes. The collection realized fairly good prices at public auction. Some doubt has been expressed whether, though the prices may have been moderately good, as compared with those which prevail for similar other woods, the cost of transit may not be prohibitive. This remark may probably hold good as respects timber from our mountain ranges; but, in these days of cheaper transit and low freight, the produce of the plains may be exported at a sufficiently profitable rate to induce the despatch of another consignment. Among other woods were logs of Box, the produce of the Himalayas. We believe that this Box is almost equal in quality to the produce of the Black Sea forests, but "the difficulty of transit from the mountains to the sea-board appears to be the great obstacle." Could this be overcome, there is apparently nothing to prevent its competing with the produce of other localities; the more so as Boxwood still continues in such great demand, and the price is so high, that engravers and artists have been endeavouring, but hitherto unsuccessfully, to introduce other kinds of wood in its place. Not very long ago it was reported that the Boxwood forests of Mingrelia, in the Caucasian range, had become well nigh exhausted; and that old forests, long abandoned, were being explored in search of trees that might have escaped the notice of former proprietors. We have not recent statistics at hand, but some three years since rather more than 2,000 tons of Boxwood, valued at about £21,000, the produce of the Government forests in the Caucasus, were exported from Poti; but so large a quantity cannot be reckoned on for the future. At the same time 1,300 tons were shipped for England from the south coast of the Caspian Sea. But little Boxwood of any size is to be obtained in England itself, and we are, therefore, necessarily obliged to draw our chief supplies from the abovenamed localities. If, therefore, among our numerous kinds of woods, any one or two could be found which would prove an efficient substitute for Box, a great desideratum would be gained. Among those hitherto brought to notice, some have been found, though close grained, to be too dark coloured, while others, possessing close grain and a lighter color, are liable to split, which is of course an insuperable objection for engraving purposes. We remember seeing some notice of Sandal wood, raised on a rocky soil, having proved to be the nearest approach, among Indian woods, to Boxwood, in working quality, hardness, and durability under pressure. This was proved some time ago at the School of Arts, Madras, where some blocks yielded

upwards of 20,000 impressions without being worn out. Whether this wood was ever sent to England in order to see if it would prove a substitute for Box in respect to quality and price, we have no means of knowing, but would be glad of information thereon."

[There are other trees in India besides *Gardenia latifolia*, which are worth trying, though that wood is perhaps the best. Most of the Rubiaceæ have a closed-grained wood, and the species of *Randia*, *Gardenia*, and *Ixora* especially are worth notice. *Murraya exotica* from the Andamans has been tried, but it warps a good deal; *Homonoya sympyllifolia* from the Lower Hills of Sikhim, where it is a common small tree with much fluted stem, is worth trying, as also might be *Tecoma undulata*, the 'Lahura' of the Punjab, and the Indian wild Olive, *Olea ferruginea*. The 'Paser,' *Parrotia Jacquemontiana*, and some of the *Rosaceæ*, such as the Cotoneasters, have also hard close-grained woods, and our readers will probably be able to suggest more which are worth experiment.—Ed.]

Seedlings of Duabanga on old Charcoal Kilns.

While lately going through the Bamunpokri Plantation in the Darjeeling Terai, I was much astonished to find every here and there a small patch of seedlings of the *Duabanga sonneratioides*. This tree, the *Lampattia* of Nepal, *Kochan* of Assam, *Baichua* of Chittagong, and *Myoukgnau* of Burma, belongs to the natural order of Lythrarieæ, and is readily distinguished in the forest by its large, curving, pendulous branches, with opposite, large, sessile leaves and terminal, big, fleshy flowers. But it is only lately that it has at all come into notice as being of any value. In Burma it is very little used, almost never in Chittagong. Mr. Mann, in his Assam List of 1872-73, speaks of it as having an inferior timber, sometimes used for canoes, and occasionally for ordinary domestic purposes, so that in reality it is only in the Darjeeling District that its value is recognized and its timber sought after. In 1874-75 it began first to be in demand for tea boxes. Up to that time planters had drawn their supplies from the large Toon trees of the hills, which they then found beginning

to become rarer and rarer, and only to be discovered in more and more inaccessible spots. Looking about for woods which might easily replace Toon, Lampattia was hit upon, partly at the suggestion of the Forest Officers, partly by the advice of the Nepalese coolies, who well knew the value of the wood in their native forests. And so it was tried, and one by one the old trees, both on private estates and to a certain extent also in the Government forests, whence in the four years ending April 1878, Lampattia trees to the value of Rs. 2,600 were extracted, shared the fate of the Toon, and were found to be getting more and more scarce. There is still, however, plenty of the wood, and as the seedlings come up profusely on the banks of rivers and in cleared spots where the soil has been turned up, there is no fear of the supply getting very short.

But to return to the patches at Bamunpokri: It has been the practice, while clearing dead wood as well as useless, old, badly-shaped and soft-wooded trees from the plantation, to sell to a neighbouring planter all this refuse material. The planter usually carried away to his factory the best pieces for fuel for his engine, and converted the rest into charcoal. Dotted about, therefore, over the plantation are the sites of old charcoal kilns, with, of course, a large quantity of refuse, charcoal dust, and burnt earth, and upon examination it turned out that it was on these sites that the Lampattia seedlings had come up in such profusion. Now, there would be nothing strange in this if the Lampattia were a common tree in the locality, but it is not so. The Bamunpokri Plantation consists of two plateaux, each with a gentle slope towards the south, and connected with each other by a rather steep hill side. The upper plateau is covered with dense high forest of big timber; the lower is the plantation, and was probably, in the days before jûm cultivation was known, a Sál forest. The slope between them is dry, with a southern aspect, and grows little beyond a few Sál and a good deal of the Rhododendron-flowered Kachnar. But at the sides of the plateaux run rivers, which meet below, and on the banks of these rivers are forests of large trees of the more moisture-loving kinds, and it is there that the Lampattia is found. Clearly

then, the seed, which is very light and slightly winged, must have been brought by the wind from the river-banks, from a distance of nowhere less than half a mile, and scattered over the lower plateau, germinating only on the old charcoal kilns, the locality where it found its most favourable conditions. It is strange, however, that it should not have germinated elsewhere on the plateau. The soil, rich with the ashes of countless jungle fires, and only recently turned up by the hoe, would, one would have thought, have been very favourable for the germination; but no, it chose out in preference the old charcoal kilns, so that, wherever such are found, one can safely predict a crop of fine strong-growing Lampattia seedlings.

Advantage has been taken of this peculiarity to make nurseries with charcoal kiln earth and attempt to grow Lampattia plantation. The seed has often been sown before with every care, but has only partially succeeded, and it is pleasing to find at last some prospect at success.

The tree grows extremely fast, very straight and strong when young, becoming in a few years' time fit for poles, and probably in about 40 years fit for tea-box scantling. It has, usually, 5 rings per inch of radius, corresponding to 6 feet in girth at the age of 57 years. There is, therefore, no doubt that it should be encouraged, quite as much as the *Pithecolobium Saman*, the *Prosopis* or the Argan tree of Marocco.

The wood is of a light brown colour, streaked with darker brown and yellow; it is rather light and open-grained, but is durable, makes fine planking and does not warp. It is highly prized for canoes, and is now considered by some as good as Toon for making tea-boxes.

J. S. G.

Notes on the occurrence of the Teak Borer Beetle in Assam.

Simultaneous with the establishment of the experimental Teak plantations at Kulsi, Assam, there appeared an insect which may yet cause considerable damage amongst the young Teak, although up to the present time its attacks have not been

very serious, only a small percentage of the trees having suffered, and many of which recovered partially or entirely.

The first symptom to be observed is the swelling just above the ground, or sometimes a couple of feet up, of the stem which is occasionally of a considerable size.

On close examination, small punctures in the bark may be noticed just beneath the swelling from which the excrements of the larvæ exude.

After a hot day, the young trees have a fading appearance, though not invariably, and the leaves shrivel up. Frequently this symptom is, however, not present, and the young tree remains apparently vigorous until the larvæ have bored their way so far into the stem that the tree is snapped off by the wind. The globular swelling is evidently the result of the efforts of nature to repair the damage, and is sometimes successful, insomuch that the tree continues to live and thrive, though with diminished vigour.

On cutting over the stem and slitting it carefully open so as to bisect it longitudinally, the larva may be discovered a little above the swelling, in the cavity formed by its having eaten away the pith of the tree completely for several inches in an upward direction. The appearance of this coleopterous larva corresponds with that given in Dr. Ratzeburg's "Waldverderber," under the head *Cerambyx*, of which it is evidently a variety; it is yellowish-white, footless, and about 1½ inches in length. It converts the pith of the tree into a kind of fibre as it bores its way up, and it utilizes some of this fibre afterwards in preparing its cocoon.

It appears usually in one and two-year old trees, but has also been found in trees of five and six years' growth. Up to the year 1877 no perfect insect, or beetle, had been discovered, although the presence of the larvæ had been noticed since 1873. In the end of March 1877, however, the Assistant Conservator of Forests, Gauhati Division, collected some sections of stems with the larvæ inside them, and had the satisfaction of finding them eventually transformed into beetles on the 21st of June in the same year, having in the meantime passed through the intermediate stage of the Chrysalis.

These beetles are very similar to the "*Cerambyx Carcharias*" shewn in the colored diagram No. II. of Ratzeburg, only somewhat smaller.

Owing to the fact of the larvæ being found in the young Teak all the year round and the variety of the perfect insect itself, it is believed that the beetle has a biennial development only, which is the case with the *Cerambyx* mentioned by Ratzeburg. The treatment in vogue at the Kulsi Plantation is to coppice all young and badly-attacked poles, and encourage the growth of the strongest shoot from the stool by removing the rest, when they appear. In the case of older and more vigorous trees, which do not appear otherwise sickly or fading, these are left alone, and often recover the effects of the borer's visitation to all appearance at any rate although trees of the globular swelling invariably remain.

A. G. MEIN,
Assistant Conservator of Forests,
Gauhati Division.

KULSI PLANTATION,
23*rd February* 1879.

The function of the Pines and the Larch in the production of Soil.

(*Continued from page* 247.)

The *Pinus Cembro*, the 'Arolle' of the Swiss Alps, is also called 'Auvier' in French, 'Arve' in German, and, though wrongly, for the name of cedar has been given it though no cedar is indigenous in Europe, 'Keder' in Russia. It probably has many other names east of the Ural Mountains. It is a sporadic growing tree, found here and there in clumps at great elevations, and scattered in places everywhere from the Alps of Provence to Kamstchatka. It seems to like the most out-of-the-way and cold corners away from the action of man and his cattle.

In France the Cembro is never found below 2,000 metres in altitude; it is chiefly indigenous to the quiet zone, between 2,000 and 2,200 metres, which also is inhabited by Marmots

It is most often found as scattered trees, here and there in the upper portion of the forests of larch and mountain pine. Under their protecting shade it has grown, and when they have later on disappeared, the 'Arolle' alone at the limit of arborescent vegetation in its turn protects as rear guard the forest whose upper limits are gradually getting lower and lower. It is sometimes found growing gregariously, as in the forest of Ayes, whose very name comes from 'Ayou,' the patois name of the Arolle, and there it is the principal tree in a forest covering 200 to 300 hectares of land. This little forest belongs to the commune of Villars-Saint-Pancrace near Briançon, and is hidden in the depths of a valley, high up in the hills behind the great peaks, and on the promontory formed by the junction of two feeders of the principal stream. It has been much cut about and damaged by the axe and by grazing, and has been to a certain extent invaded by the larch: the largest specimens measuring one metre in diameter, and eight or nine centuries old, are close to the chalets of LaTorre, whither the cattle only go for pasture on the 15th July and remain only five weeks.

The places in Europe where the Cembro is most abundant are in the Engadine and the German Tyrol. It is also found at the head of some valleys in the Carpathians and in Ural and beyond that on the Altai hills, and round the Okhotsk Sea.

The 'Arolle' is a fine tree, often 15 metres in height; it has flexible branches, which bend but do not break under the weight of the thickest snow. Its soft, bright green needles, arranged in fives, give it some resemblance to the Weymouth pine of our gardens, but the leaves of the Cembro are much more abundant and closely set, and its rounded head is often but a mass of foliage where the forked-tailed Capercailzie loves to hide, and whence the sportsman finds it difficult to dislodge him.

The bark of the Cembro, fresh and green when young, and covered with little cells full of turpentine, becomes at last dry and of a reddish grey color. The numerous roots spread around the feet of the old Cembro, stretch themselves far in

fan fashion, half exposed and fixing the soil in the most safe way possible.

The forests of Cembro prefer the fresh soils, and the glades are covered with bilberries and rhododendrons which serve as a home for the Capercailzie, the Chamois and the white Hare.

The Squirrel and the Woodpecker abound, and break open the solid scales of the cones for the sake of the nut within. The inhabitants also collect these fruits, which are sought often as a help to the scanty food of those cold regions. The seed, with a shell harder than that of a filbert, only germinates two years after its fall, and remains thus exposed to every cause of destruction; the young plant remains weak during many years, frail and liable to be trodden down by cattle, so that the reproduction of the forests, when once they have been reduced to a small number of trees, is almost entirely prevented. Here and there under the shelter of a rock, or between the roots of some light-foliaged tree, such as the larch, the last representatives of the species sometimes develop themselves by chance. Were it not for its longevity, we should know it no longer in France, and beyond purely cultural reasons, there is now some interest in preserving our few remaining Cembro pines.

The Larch (*Larix europæa*) is also a tree of northern and cold regions. It forms a genus by itself among the European conifers, and it has, by its non-verticillate ramification and its faculty of giving out numerous twigs, considerable relationship with the broad-leaved trees. Thus, in the fields of the Tyrol, larches may be seen with their branches cut off close to the stem and tall and thin like the Lombardy poplar, covering themselves with new branches along the whole length of the bole; while in some forests this pruning operation gives the village firewood, while the stem is only cut for building, the wood having often become by the process, knotty, misshapen and somewhat decayed.

Like the spruce, the larch forms large forests at the limit of forest vegetation in Northern Russia and in the Alps. It will only grow well in a dry climate and under a clear sky, so that in the Alps it is chiefly found on the Italian side, and in Russia it is chiefly found in the north-east, while the

spruce prefers the north-west with a totally different style of soil and climate. The European larch has several relations in the world, the most important of which is the American larch, better known under the names of Hackmatack or Tamarack. In the French Alps, the larch is found between 1,200 and 2,400 metres, and most common with a fresh northerly or easterly aspect. In some places still, the whole slope of a valley may be seen, covered with larch from the bottom of the valley to the line where all tree vegetation ends; the foliage is developed in spring at the time when the snow disappears from the ground at the foot of the trees, the forest gradually reclothes itself in verdure from the base to the summit, and sometimes it requires a whole month, from the middle of May to the middle of June, for such a forest to recover its full verdure. And then how fresh and tender is that verdure! Under the larches extends a green carpet sown with the varied hues of different flowers, and the foliage of the trees, of the same colour as the grass, covers itself with the red flowers which form later on the cones, while light, pure and gay, enters from every side. Life seems light like the air of the Alps, and there is nothing which can compare with the calm of these elevated regions.

The larch is a slow-growing tree: after eight months of rest growth is awakened for scarcely four; and besides, the summer is usually dry and the heat moderate. Those which add yearly one centimètre in girth are fine trees; but generally about two centuries are requisite for trees to reach 1½ metres in circumference, and then they are only at middle age; later on, the back gets thick, the top dies, but the tree continues to increase in girth. Larches of a metre in diameter are not very rare, but they must be sought for in places well sheltered from the wind. A few years ago, might have been seen, on a promontory separating the Guil from the torrent of Riou-Vert, and belonging to the village of Saint Veran, the highest in the Alps, a little hidden plateau, quite covered with big larches, containing about three hectares, and with trees whose stems had an average diameter of nearly one metre; it was a very pretty sight, but many of the trees

have since disappeared. It is also in the same canton of Aiguilles, formed by the valley of the Queyras, that the most important extent of larch forest in France, comprising 5,000 to 6,000 hectares, is found. That beautiful valley begins at the foot of Monte Viso, opens towards the west, reclosing itself with the exception of a narrow passage before joining that of the Durance. The meadows at the bottom of the valley rise to an altitude of 1,400 metres; the slope with southern aspect is covered with vast pasture grounds, and the opposite slope is covered with forests. These forests belong to the eight Communes of the valley, some of which, such as Molines and Ristolas, have their houses all built of wood provided with large balconies, of an uniform style, but blackened by time and the weather.

The larch rarely reaches a height of 30 to 40 metres; usually it stops at half that size. It has often a slightly curved bole, very conical and branched low down; its form is nevertheless always regular, and the forest is usually of pure larch unaccompanied by any other species of tree. It reproduces itself easily, although slowly, everywhere that pasturage does not prevent it; it even invades fields which have been left fallow and abandoned pasture grounds: but, under the constant action of the flocks which are yearly sent up for the summer to the higher regions, its upper limit is gradually descending lower and lower like that of all the forests of the Alps. In the Pyrenees, on the other hand, the forests of beech and silver fir, grazed over from below, seem gradually to ascend towards the inaccessible regions.

In forests of larch, trees which have been dead for more than a century are frequently found, round which young growth is no longer to be seen, and who are now the last representatives of the forest which has disappeared. In a forest in the valley of the Cervieyrette, which joins that of the Durance below Briançon, above the Côte des Chèvres, was visible, 20 years ago, an enormous larch, short, quite dead, and having even lost all its bark. At 4 or 5 metres from the ground was a thick horizontal branch, and on this dead branch

lived a larch tree already of large size, about 70 years old, and deriving its nourishment from the decomposed wood of the parent tree. Can it still be living ?

Forest Denudation and Famines.

Extract from a Paper entitled 'Irrigation regarded as a preventive of Indian famines, by W. T. Thornton, Esq., C.B., read at the meeting of the Indian Section of the Society of Arts on February 22nd, 1878.

I fear I have already detained this meeting too long, although as many persons present must be aware, I have only lightly skimmed the surface of my subject. If, then, I venture to claim attention for a minute or two more, it will be only in order to show how merely fragmentary my whole discourse has been. It has been almost confined to consideration of the best means of preventing water that might be beneficially diverted to the land from being carried uselessly by rivers to the sea, but no allusion has been made to the at least equal importance of providing beforehand for detention of part of that water on the land, and for preventing it from ever reaching the rivers. Three-quarters of a century ago, immense tracts in Southern India were overspread with jungle, and the slopes of both Eastern and Western Ghâts were almost universally forest clad, but most of the level woodland has since then been cleared for cultivation, and the hills have been stripped of their trees in order to suppy fuel for the railways. Contrary to what might have been expected, there is no evidence to show that the actual rainfall has decreased in consequence, but it is notorious that another and scarcely smaller evil has resulted. Formerly the water showered down from the skies was partially protected from evaporation by sheltering trees; its flow over the surface was mechanically resisted by standing trunks and fallen stumps, and by jungle-grass, mosses, fungi, and decaying leaves; it had time to be absorbed by the upper layer of vegetable mould, and, after this was saturated, to sink into the mineral earth below, and to fill

whatever cavities there might be still lower down, thereby converting them into reservoirs calculated to ensure the permanence of natural springs. What remained proceeded to replenish the tanks it met with on its passage; and not till all this was done did the residue find its way to the rivers, and that at a comparatively tardy pace. Now, however, as a rule, the rivers are in violent flood for about as many days as they used to be for weeks in moderate flood. No sooner is there a copious fall of rain, than a perfect deluge *scours* the fields, washes off whatever slight dressing of manure or other fertilising elements there may be on the surface, often sweeps away the growing crops, or covers them inches deep with sand, breaches entire chains of tanks, and finally reaches the rivers in torrents, which destroy, or seriously damage, massive railway bridges and still more massy anicuts. Wholly to obviate these gigantic mischiefs might, perhaps, be impossible, except by expedients more mischievous still, for no one would wish to see the corn and rice fields that have taken the place of jungles, replaced in turn by the jungles they have supplanted. Still, art and nature combined might easily, one would think, re-clothe with wood hills which nature once clothed *without* help from art; there is all over India abundance of waste land on which Government might, with profit to itself, form plantations; and kindly counsel on the part of revenue and other authorities might everywhere persuade village communities to surround their fields with hedge-rows, and to convert district roads into shady avenues. This, however, is a topic on which I cannot now dwell, though I could not altogether forbear from referring to it with the view of suggesting that, however desirable it be to extend irrigation to the utmost, there may, nevertheless, be arrangements of a different kind that may go far towards doing away with the necessity for irrigation.

Rings in Teak Wood: Are they necessarily annual?

In the number for January last of the INDIAN FORESTER was published a Memorandum on the rate of growth of teak by

Dr. Brandis. It was therein stated (see para. 3) that "it is now *established beyond doubt* that the concentric rings * * * * * * * * * * * in the wood of teak correspond each to one year's growth." The italics are mine. Now it is a well-known rule in logic that a single particular fact to the contrary destroys the truth of a universal proposition. If, therefore, I bring forward only a single instance in which the number of rings in a teak tree was in excess of the known age of the tree counted in years, the broad statement quoted from the memorandum in question falls to the ground. But it is not only one such instance that I have observed, but several over and over again, so that it is impossible I can be mistaken. In the hot weather of 1874, I copsed teak over an extensive area in the Punassa Reserve. In December, of the same year, a fire spread over a portion of this area, and killed, or badly injured, some of the coppice shoots that had come up in the preceding rains. Some of these shoots I cut off out of curiosity, intending to keep them as specimens of the vigorous early growth of teak from the stool; many more I cut back to produce a new clump of sound, straight shoots in place of those injured beyond all hope of remedy. To my astonishment I found that about two per cent. of the shoots cut off had each two well-defined rings of wood. I say *well-defined* advisedly, for they clearly were not what have been called spurious rings, which are occasionally observed even in European timber. Here there were shoots, barely six months old, which possessed two rings. I tried to account myself for this contradiction to received opinion, and the experience of such excellent authorities as Dr. Brandis and others. If I could have proved that, as often happens in our forests here, through the ravages of a caterpillar, the first flush of leaves had been destroyed and replaced by a new flush, then in the case of those shoots, in which the interval between the shedding of the old leaves and the appearance of the new was long enough to cause a cessation of circumferential growth, a double ring for that year's growth would be the result. This circumstance, however, could not be established with certainty, since the necessary special preliminary observations were wanting. The following year, 1875, I

had occasion to cut back a number of injured shoots among the re-growth of the coppice cuttings of 1871. Here, again, many shoots contained one ring in excess of the number of years in their age, and the cause of this apparent anomaly was of course less easy to explain for the same reason as before. Since then, I have observed the same anomaly over and over again, and I drew attention to it in some shoots that I sent to Calcutta with other specimens of forest produce intended for the late Paris Exhibition. Mr. Smythies, who collected the data for Dr. Brandis' Memorandum, evidently ignored the remarks I made in the paper accompanying the specimens sent, or unintentionally overlooked them.*

I think I have said enough to establish beyond doubt that two rings of wood may be produced in teak in a single year. The cause still remains to be ascertained, but it must in all probability be referred to an interval of repose, dividing the season of vegetation for the trees so affected into two distinct periods. The production of more than one ring of wood in a single year in many tropical trees and large climbers has been ascribed to this cause by all writers capable of forming an opinion on the subject. And the probability of my position is still further strengthened by observation of a teak shoot, examined last month by Major Doveton and myself, which, although the growth of the south-west monsoon of 1878, has developed a new terminal shoot about a foot long, and has thus all the appearance of a sapling two years old. In this remarkable instance, therefore, there was a cessation of longitudinal as well as circumferential growth, dividing the season of vegetation into two entirely distinct portions.

Before concluding this short note, I ought, for the benefit of those not acquainted with the teak forests of the Central Provinces, or of teak forests in other regions possessing similar conditions of soil and climate, to add a few words in explanation of a remark made *en passant* higher up. It is not uncommon for teak to be attacked over whole tracts after the cessation of the south-west monsoon by a caterpillar, which

* *The remarks were overlooked.*—Ed.

frequently destroys all the foliage and leaves the trees entirely bare. If this occurs before the end of December, or, provided the soil is moist, even later, the trees soon cover themselves with new foliage, the interval between the fall of the old and the appearance of the new leaves varying, according to circumstances, from a few days to a fortnight. To quote one of many instances, in travelling towards the end of October 1875 from Harda to Jubbulpore, I found the stretch of teak copse on the left bank of the Tawa River as denuded of foliage as if we were in the middle of the hot weather. When I was returning to Harda early in November, the whole forest was clad in bright green as far as the eye could reach.

March 1879. E. E. FERNANDEZ,
Asst.-Conr. of Forests, Central Provinces.

JJ. Official Papers.

Sind Forests.

Office of the Inspector-General of Forests;

Calcutta, the 19th January 1878.

It may be regarded as certain that the Indus Valley Railway must draw a great part of the fuel required for working the line from these forests, and that consequently the demand for wood will increase considerably.

The efforts of the Forest Department, therefore, must now be more than formerly directed to the regeneration of the forests. It seems to me that three measures should be considered, which may tend to be useful in this respect. These measures are :—

I.—To acquire as large an extent of river frontage as possible, and to take possession of all alluvium that forms in front of it, and on no account to permit any of this alluvium to be cultivated. It is well known that these fresh-formed lands cover themselves, where sufficiently high, with a complete crop, be it water-sown or wind-sown, of tamarisk, poplar, and (in Lower Sind) of babool; and, if we could get a sufficient area annually of these new lands, they would regenerate the forest in the most efficient and economical manner. But this involves two conditions—no cattle must be admitted into these kachchas, and no land must be broken up in them for cultivation. The temptation is great to make a good revenue from these rich lands, but then the young growth is lost.

On the understanding that the whole of these new lands, which are at the disposal of Government, are maintained as forest, and carefully protected, the cuttings in the older part of the forest can be considerably increased. And, as a matter of course, whenever the river sets in upon old forest, the land threatened should be cleared early enough. No trees should be allowed to be carried away by erosion; they should be cut

and utilized. This will require special arrangements and great vigilance, for the river often sets in suddenly in a new direction; but the task is not impossible, and the annual reports show that great progress has already been made in this respect. A careful account of all annual acquisitions of fresh-formed land should be kept; they should be numbered and entered as new compartments in the register, and the progress of the young growth on them should be recorded.

The area of young growth annually acquired in this manner will be an important factor in determining the quantity of wood that may be cut annually over and above that threatened to be carried away by the river.

II.—The river frontage at the disposal of Government is not sufficiently extensive to give a sufficient extent of new land in front of it covered with young growth; efforts must, therefore, be made to promote the regeneration of the old forest wherever cuttings have been made. The first step to secure this is to exclude cattle from selected blocks sufficiently long to enable the young growth to come up. Experience has shown that, wherever cattle have been excluded, and the ground was sufficiently moist, an abundant crop of babool and other trees springs up from hand-sown or self-sown seed. The annual revenue from grazing has, from 1857-58 to 1877-68, averaged Rs. 33,000, and during the three years, from 1874-75 to 1876-77, it has averaged Rs. 35,700.

It is not necessary to sacrifice the whole of this revenue, for a portion of the forests may continue to be open to cattle, and pasture being scarce in Sind, it is not unlikely that nearly the same revenue will be obtained from a restricted area; but whether revenue is sacrificed or not, selected blocks must be closed absolutely against cattle, and must remain closed, until the young growth is sufficiently advanced to be beyond the reach of cattle. I say, advisedly, *selected blocks* must be closed, for on dry ground, not moistened by overflow or percolation, the exclusion of cattle would not do much good. It is, however, for consideration whether it will pay to carry water to such lands, and in such cases cultivation would be in its place, as a temporary measure, in order to cover the cost of irrigation. Dr.

Schlich, while in Sind, I believe, initiated a system of raising babool and poplar in lines on fields, which yield their crop during a series of years, being irrigated until the young trees are sufficiently advanced to be left alone. In this manner the area covered with young growth may be considerably increased.

III.—It is obvious that the quantity cut annually in Sind must be regulated by the quantity annually produced; and, broadly speaking, we may say that the quantity of wood cut annually must depend upon *the areas stocked* with young growth of different ages. Each annual report should contain sufficient information to satisfy Government that a sufficient area of land is under young growth, be it self-sown in new lands, or produced on old lands by the keeping out of cattle (and fires, as a matter of course) and by irrigation. These considerations should regulate the quantity of the annual yield. *As regards the localities where cuttings should be* made, it has already been pointed out that loss of forest by erosion must be anticipated by cutting, and this will yield a considerable quantity of material. Otherwise I think that the general rule should be laid down, that no cuttings should be made in localities which are not protected against cattle and fires, and which are not sufficiently moist, naturally or by irrigation, to warrant the expectation that under due protection and proper management a good stock of young growth will spring up. It should be carefully considered whether forest administration in Sind is sufficiently advanced to admit of a strict observance of these principles. There may be outlying pieces of dry land which it may not be found expedient to maintain under forest, and which may be cut, therefore, without regard to reproduction; but, as a rule, cuttings should be made in such places only where there is good ground to expect that young growth will come up on the clearances made, excepting only where the land is threatened by erosion.

The preceding remarks contain nothing new; they are based on the suggestions made in my Report on the Sind Forests

which I had the honour to submit to the Bombay Government in February 1869, on the proposal made by Dr. Schlich while Conservator of the Sind forests in 1871 and 1872, and on the proposals made and progress reported in Mr. Campbell's annual reports.

These last-named reports, indeed, show that considerable progress has already been made in the direction here indicated. It may, in conclusion, be useful to state a few figures which are taken from my report of 1869, and Mr. Campbell's report of 1875-76. These figures will show that, apart from the three measures suggested to promote the regeneration of the forests, it is imperative to increase the area of the Sind forests very largely.

The area of the Sind forests was

In 1869	...	...	317,245 acres.
„ 1876	...	...	352,041 „

During the four years, from 1872-73 to 1875-76, the losses and gains by the action of the river were as follows :—

Gained	...	...	48,005 acres.
Lost	...	...	26,873 „
Excess gain	...	...	21,132 acres.

But, as the Conservator explains, all the new land consists of banks of mud and sand of little present value, while part of the land lost was covered with valuable forest.

Therefore, the whole of the gain of 48,000 acres cannot be classed as young growth: some of it may be carried away before it is raised sufficiently to become stocked; but whatever of it remains, may probably mostly, if duly protected, become covered with young forest.

In addition to this area, whatever that may turn out to be, the Conservator reports that 54,500 acres of old forest are closed against cattle and under treatment to promote reproduction These operations are of comparatively recent date, a commencement having been made in 1873 with 513 acres; but there seems good reason to hope that, if these operations are steadily continued, a considerable proportion of the forest

area will, in a few years, be stocked with young growth. Cuttings may then, as a rule, be restricted to the areas under treatment and to the areas threatened by erosion. It should, however, be stated at once that the time fixed for closing these areas placed under treatment (5 years) will be found to be much too short to do any real good. But that will easily settle itself afterwards.

The yield of the forests has been as follows, expressed in cubic feet of solid wood :—

	1866-67.	1867-68.	1874-75.	1875-76.
	Cub. ft.	Cub. ft.	Cub. ft.	Cub. ft.
Timber and building wood ...	168,680	156,629	74,209	94,248
Firewood	1,494,860	1,486,849	1,977,680	1,936,750
	1,663,540	1,643,478	2,051,889	2,030,993

As far as these figures go, they indicate that the demand for timber and building wood has diminished, but that for firewood the demand has increased considerably. So far, however, the increase here shown, has not yet been materially affected by the requirements of the Indus Valley line, and it may well be that the demand will double within a few years.

Now, it is quite impossible to say, while the forests are in their present condition, what the yield of the present area of 352,000 acres will be: their yield 10 years ago amounted to 5 cubic feet per acre per annum, and in 1875-76 it was nearly 6 cubic feet. That is as yet a very small yield: but the matter would be different if the material removed were to rise to 35 or 40 lakhs, or to more than 10 cubic feet per acre per annum. It is by no means certain whether such a quantity could, with safety, be taken from the forests in their present condition.

Under these circumstances the only thing to be done is to endeavour considerably to increase the area of the forests. The Conservator reports, in his report for 1874-75, that he had proposed the addition of 30,000 acres in the vicinity of

the line north of Sukkur; this is a move in the right direction, and every effort should be made to increase the area by the addition of large, compact blocks of forest land where wood can advantageously be produced.

It is not here the place to discuss the important question how to stimulate the consumption of timber and building wood from the Sind forests, which, as a matter of course, pays much better than firewood. The cultivation of sissoo and bamboos is a move in the right direction; and it is a matter for consideration whether the production of the poplar, mixed with the tamarisk, should not be encouraged, as the demand for this wood in Sind is likely to be greater than for babool, which is hard and difficult to work.

As regards fuel, attention should be given to the Kundi (*Prosopis spicigera*) which is valued as railway fuel in the Punjab, which is more hardy, and requires less water than either babool, poplar or sissoo, and which reproduces well as coppice wood.

The chief suggestions submitted in these remarks may be summed up as follows :—

Endeavours should be made to increase the area of the forests, particularly with the view of obtaining a longer river frontage.

Efforts must be made to stock as large an area as possible with young growth, both on new lands and by special protection and treatment in the older parts of the forest.

Cuttings should, as a rule, only be made on the specially protected blocks, except where the forest is threatened by erosion.

D. B.

Memorandum on the supply of Railway Sleepers of the Himalayan Pines impregnated in India.

By D. Brandis,

Inspector-General of Forests.

Dated Simla, *the 21st October* 1878.

In June 1877, the Government of India, in the Public Works Department, suggested special consideration of the subject of the supply of indigenous timber for railway purposes, as at that time it was supposed that the war in Europe might possibly interfere with the supply of sleepers for railways in India.

2. The result of the enquiries then made, and of all the information which was previously at the disposal of the Government of India, is that the supply of timber sufficiently durable for railway sleepers in India is not sufficient at present to meet the requirements for construction and renewals, and will not be sufficient until the forests in charge of the Forest Department have grown up, and this will not be for a long series of years.

3. The principal woods which are sufficiently durable for this purpose are *teak*, *sál* and *deodar*. The statements appended to this Note show the number of sleepers furnished to State Railways since 1870 by the Forest Departments in the Punjab, the North-Western and Central Provinces until the 1st April 1878, and in Bengal and Burma until the 1st April 1877. These statements do not exhibit all that has been done in this respect by the Forest Department in these provinces, for much timber sold by them which was afterwards used by the railways was sold in the shape of logs, and not in the shape of sleepers, and is therefore not entered in these returns. Nor do these statements give the cubic contents, for a portion were broad and a portion were narrow-gauge sleepers.

From a detailed statement lately received from the Director of State Railways, Central System, it appears that the following quantities of different kinds of timber were received on the

Rajputana, Sindia, Holkar and Neemuch State Railways up to the 30th September 1877:—

Kinds of Timber.	Number of sleepers.	Cubic feet.
Deodar	1,472,759	4,450,262
Chir (*Pinus longifolia*) (creosoted)	2,000	6,044
Chir (uncreosoted)	11,830	38,558
Kail (*Pinus excelsa*)	2,628	3,603
Creosoted pine from Europe	561,919	948,237
Teak	3,245	3,826
Dhaura (*Lagerstrœmia parviflora* and *Anogeissus latifolia*)	3,082	9,819
Hardu (*Adina cordifolia*)	2,396	3,594
Anjan (*Hardwickia binata*)	2 167	3,250
Bija sâl (*Pterocarpus Marsupium*)	976	1,464
Other woods	58,813	96,039
Total	2 121,815	5,565,496

4. The chief object of these statements is to show the relative importance of the different descriptions of timber; and it will be seen at a glance that of indigenous timbers, *deodar*, *teak* and *sál* have been the chief kinds supplied. There are numerous other durable woods; but some of these are so hard, heavy and difficult to work, that they are not in favour with railways, such as Anjan (*Hardwickia binata*), Babul (*Acacia arabica*), Sundri (*Heritiera littoralis*), Mowah (*Bassia latifolia*) and Iron-wood (*Xylia dolabriformis*). Others are not sufficiently abundant, and are too valuable for the requirements of the local population to be available for railway sleepers. To this class belong Blackwood (*Dalbergia latifolia*), Sissu (*Dalbergia Sissoo*), Bija Sâl (*Pterocarpus Marsupium*), the species of *Artocarpus*, and numerous other kinds.

5. I have no doubt that eventually some woods, which are abundant, though they are not as durable as teak, sál and deodar, will be used to some extent; and that by careful seasoning and cutting them at the right time, their durability can be somewhat increased, but this source cannot be regarded as of great importance. To this class of woods belong, among others, Saj (*Terminalia tomentosa*), Dhaura (*Anogeissus latifolia* and *Lagerstrœmia parviflora*), and the other species of *Lagerstrœmia*.

6. Speaking broadly, it must be acknowledged that, in considering the supply of indigenous timber for railway purposes, we must limit our enquiries to teak, sâl and deodar.

Large supplies of teak timber for railway purposes can at present only be expected from Burma, the forests of North Kanara, and to a smaller extent from the forests in the south-eastern districts of the Central Provinces, Bastar and other Native States adjoining them. But the high price which teak commands will always prevent its being used, except locally, on any large scale for railway sleepers. Teak sleepers are, and will doubtless chiefly be, used on railways in Burma, and to a small extent on some of the lines of South and Central India, as well as in Bengal, a short distance inland from Calcutta. But for the great Railway system of Northern India, teak sleepers cannot be thought of.

7. The supply of mature sâl timber in the forests under the control of Government is very limited at present. The sâl forests of Bengal are expected eventually to yield a very large annual outturn, and may, 50 years hence, be found sufficient to supply the requirements of all railways in Lower Bengal; but at present large cuttings are not possible. The forests of the eastern districts of the Central Provinces will furnish sleepers for renewals on the lines within easy reach of Jubbulpore, and perhaps for the line intended to be built eastwards from Nagpur.

8. The sâl forests in the Sub-Himalayan tract of Oudh and the North-West Provinces do not contain mature timber enough to do more than supply local demands, and cannot, for many years to come, be depended upon for large supplies of railway sleepers.

The only extensive sâl forests which can be expected at the present time to furnish large supplies of railway sleepers are those in Nepal; the authorities in charge of these forests are most anxious to develop the export of timber which can be floated down by the numerous feeders of the Sarda, the great Gunduk and the Ganges rivers, and the Railway authorities will do well to utilize this source of supply to the utmost. The supply from this source ought to furnish renewals for a portion of the Oudh and Rohilkhand lines, and for the East Indian

Railway below Allahabad, and sleepers for construction of provincial railways in Lower Bengal.

9. As regards deodar, matters are similar. The quantity of mature timber in the forests, leased and British, under the control of the Forest Department of the Punjab and the North-Western Provinces, is very limited, and has been so much diminished by heavy fellings to supply sleepers for the Rajputana and Punjab lines, that cuttings must, for many years to come, be reduced considerably, and no considerable supply of sleepers can be expected from that source. Small quantities may be obtained from Native States between the Beas and Tons rivers, the forests of which are not leased by Government, but the largest supply must be expected from Kashmir. The deodar forests in that State should be drawn upon largely for the extension of the Northern Punjab State Railway, and they may furnish renewals for the Sind, Punjab and Delhi, and part of the Indus Valley Railways.

10. These are the chief sources of indigenous sleeper-supply. It will be understood that I have purposely limited my remarks to general results, but they can be relied upon for practical purposes. Small supplies of durable sleepers may here and there be obtainable otherwise, but the sources mentioned are the only ones which can be depended upon for large quantities.

11. At the present time, I understand no difficulty is experienced in the supply of sleepers for construction and renewals on the State Railways and guaranteed lines. Both iron and creosoted pine sleepers are obtained in sufficient quantities, and at exceedingly low rates from Europe at the present time.

Thus, with the supply from Europe, and the existing indigenous sleeper-supply, the present requirements of the railways are fairly met. But these sleeper-requirements must increase on account of the contemplated extensions, and the increase of renewals on the older lines. The renewals on the East Indian Railway alone fluctuate between 150,000 and 200,000 broad gauge sleepers annually, and will soon reach 200,000 sleepers a year. It would probably be an advantage to that line if the renewals of the upper portion above Allahabad could be provided from indigenous sources.

12. Even with the present cheap rates and the abundant supply of sleepers from Europe, there must be a portion of the inland districts of North India, for which it would be desirable to have a supply of sleepers on the spot from the Himalayan and sub-Himalayan Forests. I am aware that it is considered desirable, gradually, to substitute iron for wood sleepers throughout India, and that it is hoped that the Bengal Iron Works will be equal to supply a very large proportion of the sleepers that will be required by railways in India. But, whether the iron-sleepers come from England or from Bengal, there must be certain lines in the inland districts of North India for which it would be both convenient and economical to have local sources of sleeper-supply.

13. And in an undertaking of such magnitude and rapid growth as that of the Indian Railways, it certainly will be prudent not to rely upon one source of supply alone, but to have a second source of supply to fall back upon, and thus to leave a broad margin for accidents and unforeseen contingencies.

14. Almost simultaneously with the construction of the first railways in India, the idea was started of increasing the durability of Indian woods by impregnating them with antiseptic substances. The experiments made in this respect have been numerous, and an account of them is given in paragraphs 24 to 40 of Dr. Warth's report of September last. The results have not thus far been satisfactory; nevertheless the impregnation of indigenous timber with antiseptic substances is the chief measure by which, for certain districts of North India at least, the supply of durable indigenous sleepers can be considerably increased.

15. In a report submitted to Government in January 1863, on the supply of indigenous sleepers in India, I drew attention to the necessity of testing the Himalayan pines in a systematic way as regards their impregnation with antiseptic substances; and I then said "the question is one of experiment, and the sooner this experiment is made on a sufficiently large scale, the better."

16. In a later report on the same subject of April 1870, I submitted my views on this subject as follows:—

"To supplement the supply of woods which are naturally

durable, it will be necessary, I believe, to undertake, on a large scale, the impregnation of the inferior pines with antiseptic substances. The species which I have mainly in view, and of which there are extensive forests, either leased or British, are the following :—

(1.) *Pinus longifolia.*
(2.) *Pinus excelsa.*
(3.) *Abies Smithiana* (Himalayan spruce.)
(4.) *Abies Webbiana* (Himalayan silver fir.)

"The larger portion of the forests of these kinds are at present without any value, there being no considerable demand for these woods, and any measures that will increase the demand will, in many ways, have a beneficial effect upon the management of the forests. For instance, in those tracts where the deodar is mixed with the inferior pines, the forest cannot be worked in a satisfactory manner if felling operations are limited to deodar; and in other parts, it will not pay to make roads and slides, unless a large quantity of timber is available for removal from one locality.

"In short, if we can manage to utilize the extensive forests of the inferior kinds of pines, it will be possible to place the working of the Himalayan forests upon a much more satisfactory footing. This is an advantage independent of increasing the supply of timber."

17. In 1875, the Government of India placed Dr. H. Warth, Collector of Inland Customs, Mayo Salt Mines, on special duty to work up the information which I had collected regarding the impregnation of timber, and the result was a report on the subject, which was published in the INDIAN FORESTER of July 1876.

In 1876, when Dr. Warth was at home on furlough, he was, at the suggestion of the Government of India, directed by the Secretary of State to examine certain impregnation works in Germany and Austria, and particularly to report upon the experience gained in these countries regarding the durability of sleepers impregnated with chloride of zinc and sulphate of copper. His report, which was dated December 1876, was printed in England.

And in July of this year, Dr. Warth was again, by the order

of the Government of India, placed upon special duty to prepare estimates for setting up works for impregnating the Himalayan pines with metallic salts. This last report is dated 14th September 1878.

18. As stated in paragraphs 28 and 29 of Dr. Warth's last report, a pneumatic apparatus for impregnating sleepers of *Pinus longifolia* with creosote was set up at Aligarh in 1868, and was worked successfully for some time. The creosote was imported from England, and its cost at the works is reported to have been from 4 to 6½ annas per gallon, not counting the cost of the iron tanks in which it is imported, and which, to the extent of the supply then obtained, were utilized or sold for full value. With a large steady annual supply of creosote, however, the disposal of these tanks for full value would be difficult, and this would increase the cost of creosote considerably. Even at the rates mentioned, the cost, reported from one rupee to two rupees two annas per sleeper, would, as a rule, be prohibitory. For the present, therefore, the idea of using creosote must be given up, though it is not impossible that hereafter it may be manufactured in India. The next best substitutes for creosote are certain metallic salts, *viz.*, corrosive sublimate, sulphate of copper, and chloride of zinc. The result of the experience regarding the preservative power of these substances is recorded in the three reports submitted by Dr. Warth on the subject, and particularly in paragraphs 10 to 18 of the memorandum of September last. There is every reason to believe that those substances will prove effective in India, provided the processes are applied with due care and with due consideration of all circumstances, particularly as regards the drying of the sleepers after impregnation. Regarding the cost of the process, reference is requested to paragraphs 41 to 58 of Dr. Warth's present report, which shows that with an annual outturn of 200,000 sleepers, the cost, including the cost of the metallic salts, will amount to 8 annas per broad-gauge sleeper.

19. There is good ground to believe that it will be possible to deliver annually 200,000 sleepers, or a larger quantity of the species mentioned above, at the impregnating works, at rates varying from Rs. 1-8 to 3, and that it will be possible to

sell the impregnated sleepers at the works at Rs. 3-8 a piece all round. This estimate relates to broad-gauge sleepers; but it can only be maintained if the demand is steady, so that all operations can be arranged accordingly. A fluctuating demand and sudden irregular indents for the delivery of large quantities at short notice must always result in increased cost of the sleepers.

20. The question now arises, whether at the rate named there is any prospect of selling annually 200,000 broad-gauge or their equivalent in metre-gauge sleepers in North India. In estimating the annual sleeper requirements of the lines in North India, it has been assumed that sea-borne sleepers can compete with indigenous sleepers to a distance from the port of from 500 to 600 miles. Thus, it has been assumed that the Rajputana line will be supplied with sea-borne sleepers as high up as Ajmere, and the Holkar and Neemuch lines as far as Neemuch. The Indus Valley line, the Great Indian Peninsula and East Indian Railways have been entirely omitted from the calculations.

21. The following statement shows the length of lines in North India open on 30th June last, and those in progress on that date, all those lines or sections of lines which, it is presumed, can be supplied economically by sea-borne sleepers being excluded :—

Length of lines open and in progress on the 30th June 1878.

Lines of Railway.	Open on the 30th June 1878.		In Progress.	
	Broad-gauge.	Metre-gauge.	Broad-gauge.	Metre-gauge.
	Miles	Miles.	Miles	Miles.
Punjab Northern State Railway	103*	....	71	....
Muttra-Hathras	.....	29	.....	....
Rajputana (to Ajmere) ...	.....	400	.....	.....
Scindia (to Gwalior) ...	34	....	41	....
Neemuch (to Neemuch) ...	.....	.....	.....	133
Oudh and Rohilkhand (whole line)	544	.....	3	.....
Sindh, Punjab and Delhi Railway (to Multan) ...	553	.....	.....	.....
Total ...	1,234	429	115	133

* 103 miles, metre-gauge, line open on 30th June. The broad-gauge line 103½ miles, was opened on 6th October 1878.

22. The experience gained on the East Indian Railway justifies our estimating the life of a heart-wood sleeper of sâl at 14 years; but taking the sleepers now in use all round, 12 years may be taken as the average duration of sleepers. Accordingly, assuming one-twelfth as the annual figure for renewals, we have the following :—

Gauge.	Length of lines open on the 30th of June 1873.	Requirements for renewals in length of line.
	Miles.	Miles.
Broad	1,334	103
Metre	429	36

In these estimates no renewals are included for the lines now in progress and not yet open for traffic.

23. As regards new constructions, we may assume that during the next five years, 50 miles annually on the broad-gauge will be built in the Punjab, and 100 miles on the narrow-gauge in the North-Western Provinces. If we add to this the renewals, we find the total annual requirements of sleepers in round numbers as follows :—

Gauge.	Miles.	Sleepers, per mile.	Total sleepers.
Broad ...	150	1,800	270,000
Metre ...	135	1,800	243,000
Total ...	285	3,600	513,000

24. The following statement shows the cost of iron and wooden sleepers per mile imported by sea at the limits of land transport here assumed. The cost of the land transport is estimated at Rs. 15 per ton for 500 miles, which is equal to $\frac{1}{27}$ pies per maund per mile. This is rather too low an estimate, but it is adopted here in order to be on the safe side.

Cost of imported sleepers per mile of line at sea-port and up-country.

Sleepers of iron and wood imported from England at present prices, per mile of single line.	Iron pot sleepers.		Creosoted pine sleepers.			
	Broad-gauge.	Metre-gauge.	Broad-gauge.	Metre-gauge		
Weight of sleepers in tons ...	146	66	125	55		
A.—Cost at sea-port.	Rs.	Rs.	Rs.	Rs.		
(Reported present rates) ...	12,000	5,496	4,730	2,606		
B.—Transport by rail—	Rs.	Rs.	Rs.	Rs.	Distance *vid*	Miles.
To Multan ...	2,650	1,198	2,269	980	Indus Valley and Sindh Railways ...	[redacted]
„ Ajmere ...	2,667	1,206	2,284	987	Bombay, Baroda and Central India and Western Rajputana Railways ...	609
„ Neemuch ...	2,615	1,182	2,238	967	Great Indian Peninsula and Holkar Railways.	597
„ Jubbulpore	2,694	1,217	2,306	996	Great Indian Peninsula Railway	615
„ Allahabad ...	2,470	1,117	2,115	914	East Indian Railway from Howrah. ...	564
A + B.—Cost of sleepers per mile of single line—						
At Multan ...	14,650	6,694	6,999	3,586		
„ Ajmere	14,667	6,702	7,014	3,593		
„ Neemuch ...	14,615	6,678	6,968	3,573		
„ Jubbulpore	14,694	6,713	7,036	3,602		
„ Allahabad ...	14,470	6,613	6,845	3,520		

25. It has been stated above that it will be possible to deliver broad-gauge impregnated sleepers at the impregnating works for Rs. 3-8 per sleeper. At 1,800 sleepers per mile, this would amount to Rs. 6,300 per mile. It will be explained

further on that the works will probably be set up near Delhi on the Jumna, and at Rajghat on the Ganges river; and it is obvious that from these points, or from points similarly situated, sleepers at Rs. 3-8 a piece (broad-gauge) will, even at the present low prices, compete successfully against sea-borne sleepers.

And it may be assumed as certain that creosoted pine sleepers will long continue to be imported at the rate of Rs. 2-8 per broad-gauge sleeper, but that the rate will again approach the usual one of Rs. 4.

26. Under these circumstances, it may reasonably be expected that the lines mentioned, the annual sleeper requirements of which during the next five years have been estimated at 270,000 broad, and 243,000 narrow-gauge, will be chiefly dependent upon the supply of indigenous sleepers, and these are, as already explained, the following :—

(1.) Sâl sleepers from Nepal.

(2.) Deodar sleepers from Kashmir.

(3.) Impregnated pine sleepers from the Jumna and Ganges rivers.

It cannot be expected that sâl and deodar sleepers (broad-gauge) will ever, to any large extent, be delivered at Rs. 3-8 per sleeper; they will always command from Rs. 4 to 5 delivered on the line.

Therefore, it is likely that at the rate mentioned (Rs. 3-8), there will be a certain demand during the next five years for at least 200,000 broad-gauge, or the equivalent of narrow-gauge sleepers a year. And it is obvious that a rise in the cost of sea-borne sleepers, and any increase in the import trade up-country which will raise the cost of carrying sea-borne sleepers inland, must necessarily increase the demand for indigenous sleepers.

27. It is impossible now to predict whether the pine sleepers proposed to be impregnated with metallic salts will attain a durability equal to that of sâl and deodar sleepers or of creosoted pine sleepers imported from England. This is the chief element of doubt in the matter; but the experience gained on this subject in Europe justifies the assumption that the difference in the life of creosoted sleepers and of sleepers

properly impregnated with the metallic salts named, will not be very considerable.

It has been proposed, in the first instance, to import from Europe, and lay down in India, a quantity of sleepers impregnated with sulphate of copper and chloride of zinc, and not to set up impregnation works, until the duration in India of sleepers thus impregnated has been determined by actual experience. It must be remembered that, if this plan is followed, 10—15 years at least must elapse before a reliable result can be obtained in this respect; and within this period, difficulties in regard to the sleeper supply in the inland districts of North India are sure to arise, which it may then perhaps only be possible to avert by cutting the last remaining stock of mature sâl and deodar in the Government forests. Such a contingency must by all means be avoided; the few remaining forests under the control of Government in Northern India, which still contain large quantities of mature sâl and deodar timber, must now be worked with sole regard to their maintenance and improvement as permanent sources for the supply of these woods; and, if this is done, large supplies of these woods will not be possible for many years to come. It seems to me that rather than risk being compelled to cut the last remaining stock of mature sâl and deodar in the Government forests, it would be wiser to risk the comparatively small capital outlay which the establishment of impregnation works in India involves. In paragraph 55 of his report, Dr. Warth estimates the total capital outlay on account of these works at Rs. 1,19,000, and his estimate is liberal in every respect.

28. It has been suggested to procure 40 miles of sleepers, *viz.*, 20 miles impregnated with chloride of zinc and 20 miles impregnated with sulphate of copper. According to the figures entered in paragraph 23, the cost of a mile of creosoted sleepers (broad-gauge) from England in Upper India amounts to Rs. 6,900, and it is not likely that sleepers impregnated with metallic salts, which must be procured specially for the occasion from the Continent of Europe, will be obtained for less. The experiment, therefore, will cost Rs. 2,76,000, and it could not well, with any reasonable chance of success, be

made on a smaller scale. But the result of the experiment will not necessarily give a reply to the question whether sleepers of the Himalayan pines, impregnated with special regard to the requirements of the climate of Upper India, will prove sufficiently durable to be employed with advantage. In the impregnation with metallic salts in a watery solution, the drying of the impregnated sleepers will probably be the chief difficulty to be contended against in India, and the process of drying the impregnated sleepers will require special care in the works proposed to be set up. If, for instance, the sleepers impregnated in Europe with sulphate of copper and chloride of zinc were not properly dried, they would split and thus prove unsuitable. Again, some of the Himalayan pines will probably be found to be more useful sleeper woods when impregnated than the European woods which are ordinarily used for impregnating with metallic salts.

29. The total cost of Himalayan pines impregnated in India for 40 miles of broad-gauge line will, at Rs. 3-8 per sleeper, be Rs. 2,52,000. The laying of these as an experiment will, in due time, give a more direct and practically useful result than the sleepers procured from Europe: and if, as I have no doubt will be the case, impregnation in India proves successful, almost any quantity of sleepers thus impregnated can be turned out annually, for the forests of the species mentioned are very extensive, well-stocked, and nearly untouched. At present they are almost valueless for export. I submit that the right thing to do is to make both experiments; to set up the impregnation works, and to procure 40 miles of sleepers impregnated with metallic salts from Europe. Final results regarding the durability in India of sleepers impregnated with metallic salts, can in either case not be obtained under 10 to 15 years; and this being so, it is clearly best to make the experiment as complete as possible.

30. In case it should be decided to accept the proposals now submitted, and to set up works in Upper India, I would suggest that, before the copper cylinders are purchased, some further data be obtained from France and Italy regarding the experience obtained on the railways in those countries, with

reference to the durability of beech and pine sleepers impregnated with sulphate of copper by the pneumatic process. It is generally known that the results have been satisfactory; but specific data are wanting from those countries, and should be obtained. The forest officers who have received their professional education in France are all familiar with French, and any one of them who may be at home on leave would be competent to undertake this duty. The data should be collected on the spot at the head-quarters of the different railways; the impregnation works should be visited, and a collection be made of all recent publications in France and Italy bearing on the subject. A statement of the lines on which sleepers thus impregnated are used, and the annual outturn of such sleepers from the works, should be given as far as practicable. The opportunity should be taken to enquire into the extent to which Boucherie's process is used, and the experience gained regarding the results obtained by that process. Paragraph 54 of Dr. Warth's report shows that the cost of the copper cylinders and bronze frames alone amounts to £4,540, whereas the total cost of the machinery expected from England will not exceed £6,400. Before incurring this part of the outlay, therefore, it will be well to procure by direct enquiries on the spot the latest experience regarding the durability of sleepers impregnated with sulphate of copper by the pneumatic process in France and Italy.

31. A few remarks should now be made regarding the question where the works should be established. On this subject I have consulted Mr. Greig, the Conservator of Forests, Central Circle, in the North-Western Provinces, and Captain Bailey, the Conservator of Forests of the School Circle, and the following remarks are chiefly based upon the data furnished by these officers. The four species, the wood of which it is proposed to impregnate in the first instance, have been mentioned already (paragraph 16). The commencement will probably be made with chir (*Pinus longifolia*), extensive forests of this tree being close to the banks of several streams which admit of floating, chiefly in the basin of the Tons and Ganges rivers. The works should, if possible, be set up at the point where

water carriage ceases, and it will, therefore, be best to establish two separate factories, one for the sleepers from the Tons, the other for those from the Ganges river. Eventually, I have no doubt that the wood of the other species also will be brought down and impregnated. These kinds also will, in the first instance, be procured from the Tons and Ganges forests, so that the following remarks are applicable to the supply of sleepers of these kinds also, except that they grow at higher elevations, and that the working season in the forests in the case of these woods is not in winter, but in spring, summer, and autumn.

32. For the timber from the Tons river, the works will probably have to be set up at Jagadri, or at a place near Delhi. The sleepers which come down singly are caught and rafted at Dagh Pathar below the junction of the Tons with the Jumna river; the rafts are then floated down the Jumna river and Western Jumna canal. If the works were established at Jagadri, they would be near the canal and the Sindh, Punjab and Delhi Railway, and the sleepers would reach that place in about 105 days from the time of being launched in the forest. There would be little chance of interruption on the 28 miles of canal from its head to Jagadri, as this portion of the canal is broad. It is estimated that the cost of the sleepers delivered from the forest at Jagadri would be under Re. 1-12 per sleeper.

33. If it should be decided to establish the works near Delhi, then the best place would be at a station on the Rajputana line, opposite Metaika-phal, where the railway crosses the Western Jumna Canal. Rafts can usually be floated as far as this; but they may occasionally be stopped by insufficiency of water at Rohilla Khan Serai, 5 miles up the canal, in which case the sleepers would either be floated singly or carted to the factory. In any case, the cost of the unimpregnated sleepers near Delhi would be under Rs. 2-4 a piece. The transit fom Jagadri to Delhi would ordinarily take about 15 days, and the risk of delay would be somewhat greater than in the case of Jagadri. A certain amount of risk of delay is inseparable from floating on the canals; but by good management, this may to a great extent be obviated. The canals are

usually closed for cleaning in January, and by that time the floating of the year should be completed.

34. The forests of *Pinus longifolia* are at low elevations in the valley of the Tons, and work in them can only be carried on from October to April. Beginning work in October, all sleepers on the bank of the river by 1st March could be launched and floated to Jagadri by June; those sawn and carried in March and April could be launched in September and delivered at the works by December. Thus, the great mass of the sleepers would be delivered at the works during two seasons of the year, *viz.*, in June and December.

35. It is not at present considered probable that it will be found advantageous to send the sleepers to Delhi by the river. On that route the rafts are sent down by canal to Daduper, (14 miles below the canal head-works). Here, when waste water is available, the rafts are broken up, and the sleepers carried over the escape bund; they are then re-rafted and sent down the escape channel to the Jumna. When there is not sufficient water in the escape channel, the rafts are sent on 5 miles further to Madelpur, where they are broken up, and the sleepers are carted 3 miles to the Jumna. On reaching the river, they are re-rafted and floated down to Delhi. But this route is considered much more uncertain than that to Metaika-phal by the canal.

36. Two other places have been thought of—Saharanpur on the Eastern Jumna canal, and Rampur Mandi in the Dún on the Jumna river. The Eastern Jumna canal is not adapted for navigation, owing to numerous masonry weirs in its course not being provided with locks. No rafts would live over these weirs, and single sleepers could not be allowed to go over them, as the weirs would not stand it. It would, however, probably be possible to fit the canal for floating single sleepers by erecting floating booms above each weir and constructing slides of wood over the weirs. This would, however, increase the expense, and the cost of sleepers delivered at Saharanpur would be greater than at Jagadri.

37. Rampur Mandi on the Jumna river below its junction with the Giri, or rather a place opposite to it in the Dehra

Dún, would have the great advantage of being nearer the forests. There would be no risk of detention, and the delivery of the sleepers at the works could be better regulated. The works would be under constant supervision by the Conservator of Forests of the School Circle; they would not necessarily form a separate charge, as would be the case if they were established at Jagadri or near Delhi, and consequently the item of officers' salary, which in the estimate drawn by Dr. Warth, (paragraph 56) amounts to Rs. 12,000 out of a total annual outlay of Rs. 47,527 for working charges, might be considerably reduced.

38. The drawback to this plan would be the expense of carting the sleepers to Saharanpur, which would cost at least 6 annas per broad-gauge sleeper. But if a branch railway were built from Saharanpur to the foot of the hills below Chakrata, this objection would, to a great extent, be obviated. The line would probably pass within 3 or 4 miles from the place, and a tramway might be run into the works. On the assumption that 100,000 sleepers were procured from the Ganges, and the same quantity from the Tons, about 7,000 tons of timber would be carried annually by that line—a distance of about 40 miles to Saharanpur. The freight might be fixed high, so as to yield a gross income of say Rs. 20,000 a year to the railway, which would be an acceptable addition to the earnings of the railway, considering that most of the traffic on that line would be up-country. This would add 3 to 4 annas to the cost of the sleepers, which additional charge would probably be counterbalanced by the other advantages of the place. It is estimated that the sleepers from the forest might be delivered from the forests at Rampore Mandi at from Re. 1-8 to Re. 1-10 each.

39. The sleepers brought from the Ganges would also be cut and sawn up between October and May. Mr. Greig hopes that it will be possible to float them down the Ganges to Rajghat, where the Oudh and Rohilkhand Railway crosses that river. At that place they would be delivered twice a year, in May and June and in October and November. The chir forests on the feeders of the Ganges are very extensive;

those in the Alaknanda and Bhillang valleys would probably be taken in hand first; and Mr. Greig hopes, if all goes well, to be able to deliver the unimpregnated sleepers at Rajghat at the rate of Re. 1-8 to Re. 1-10 per broad-gauge sleeper.

If these anticipations are realized, then the works for the timber from this river will be established at Rajghat, and arrangements will be made for an annual delivery at that place at the outset of 100,000 sleepers.

40. If the proposals here submitted are approved, then the first step should be to put the forests in order which are to yield these sleepers, by making roads, protecting them from fire, and preparing a preliminary plan of working; and the more time can be given for this preliminary work the better. As far as the interests of forest administration are concerned, nothing would be gained by hurrying on the establishment of these impregnation works, provided it is decided to make a commencement, as soon as all needful preparations have been completed. Indeed, the present time is by no means favourable to the undertaking, on account of the unusually low prices of both iron and timber sleepers imported from Europe.

41. There can be no doubt that, as far as the railway interest is concerned, it will be wise and prudent to give encouragement to all measures which may tend to increase the supply of indigenous sleepers. But the necessity of these measures will, perhaps, be felt more keenly when the cost of imported sleepers has risen to a higher figure than it stands at present.

42. The practical question which now calls for decision is, whether it is likely that there will be a demand in North India for an annual outturn of 200,000 broad-gauge sleepers, impregnated with metallic salts. As soon as this question has been settled in the affirmative, the preliminary steps here indicated should at once be taken; and when the works have once been commenced, it may be confidently predicted that the business, if properly managed, will develop largely; and that by gradually adopting improved methods of impregnation, the wood of the Himalayan pines will be made as durable as

that of deodar or creosoted pine from England. In the same measure as success in this respect is attained and recognized, the demand for these sleepers will increase; and thus the object will eventually be gained of utilizing the trees associated with deodar in the forests, and of thereby placing the working of these deodar forests upon a sound and satisfactory footing, while at the same time largely increasing the supply of indigenous sleepers. And when all the experiments proposed to be made have been completed, and when the system of impregnation most suitable for India has become a regular matter of routine, it will then, perhaps, be possible to make the impregnation works over to private enterprize, and for Government to withdraw from this part of the business. But the commencement must be made by Government.

Statement showing the number of Sleepers supplied to State Railways by the Forest Departments of the North-Western Provinces, the Punjab, and the Central Provinces up to 1st April 1878, and in the case of Bengal and British Burma up to 1st April 1877.

Name of Railway.	Description of Sleepers.	North-Western Provinces.	Punjab.	Central Provinces.	Bengal.	Burma.	TOTAL.
Rajputana State Railway—							
Delhi District	Deodar ...	441,029	58,590	.....	.....	.....	499,619
Agra ,, ...	Deodar ...	768,234	.....	.....	.....	.....	768,234
	Sâl ...	25,491	.....	.....	.....	.....	25,491
	Sâl and Chir ...	22,900	.....	.....	.....	.....	22,900
Ajmere ,, ...	Dhaura ...	961	.....	.....	.....	.....	961
	Deodar ...	94,984	.....	.....	.....	.....	94,984
	Sâl ...	550	.....	.....	.....	.....	550
	Sâl and Chir ...	10,102	.....	.....	.....	.....	10,102
Punjab Northern State Railway ...	Deodar ...	.....	105,120	.....	.....	.....	105,120
Indus Valley State Railway ...	Deodar ...	.....	18,866	.....	.....	.....	18,866
Holkar State Railway	Dhaura ...	.....	.....	746	.....	.....	746
	Anjan ...	.....	.....	2,062	.....	.....	2,062
	Hardu ...	.....	.....	2,385	.....	.....	2,385
	Bija Sâl ...	.....	.....	1,077	.....	.....	1,077
Wardha Valley Railway ...	Teak ...	.....	.....	63,921	.....	.....	63,921
Northern Bengal State Railway	Sâl ...	.....	.....	.....	41,336	.....	41,336
	Saj ...	.....	.....	.....	723	.....	723
	Other kinds ...	.....	.....	.....	305	.....	305
Rangoon and Irrawaddy State Railway ...	Teak ...	.....	.....	.....	.....	156,138	156,138
	Other kinds ...	.....	.....	.....	.....	19,402	19,402
	TOTAL ...	1,364,251	182,576	70,191	42,364	175,540	1,834,922

Statement showing the number of Sleepers supplied to State Railways by the Forest Departments of the North-Western Provinces, the Punjab, and the Central Provinces up to 1st April 1878, and in the case of Bengal and British Burma up to 1st April 1877.

Description of Sleepers.	North-Western Provinces.	Punjab.	Central Provinces.	Bengal.	Burma.	TOTAL.
Deodar ...	1,304,247	182,576	...	...	...	1,486,823
Teak... ...	...	...	63,021	...	166,138	230,059
Sál	26,041	...	...	41,336	...	67,377
Sál and Chir ...	33,002	...	...	...	...	33,002
Bija Sál ...	...	...	1,077	...	...	1,077
Saj ...	...	...	...	723	...	723
Dhaura ...	961	...	746	...	...	1,707
Anjan ...	...	...	2,062	...	...	2,062
Hardu ...	...	...	2,385	...	...	2,385
Other kinds ...	...	...	...	305	19,402	19,707
TOTAL ...	1,364,251	182,576	70,121	42,364	175,540	1,834,922